GIS Community of Practice Monthly Forum

Last Wednesday of the month

Wednesday, February 28th , 2024
1:30 – 2:30 PM

California Department of Technology
STRATEGY INNOVATION DELIVERY

CA.GOV

Welcome to the GIS CoP Forum!

"In cartography, as in medicine, art and science are inseparable. The perfect map blends art and science into an effective tool of visual communication." ~ **Dr. Keith Harries, Mapping Crime: Principle and Practice**

GIS Community of Practice (CoP)

- Welcome to the GIS CoP forum.
- For the best experience, please use your computer to join the meeting.
- Mute your audio.
- Turn off your video unless you’re presenting or in active discussion.
- Use the raise hand button or the meeting chat for comments and questions.
- We will begin shortly.

GIS CoP Agenda

Welcome

- Lothar Petrik, CDT Data Engineering Architect

Main Topics

- Jim Spero, CalFire (jim.spero@fire.ca.gov)
  "Examining Building Footprint Sources"
- Fennis Reed, Department of Finance (fennis.reed@dof.ca.gov)
  "Small Area (population) Estimates"

Announcements

- Open to members

Conferences/ Events

- CalGIS – March 18-20, 2024 – Visalia, California
- ESRI User Conference – July 15-19, 2024 – San Diego, California

Strengths of Building Footprint Sources

GIS Community of Practice Meeting

2/28/2024

Jim Spero

FRAP Use Case – WUI Definition

FRAP needs to characterize areas to reflect the relative exposure of urban assets at risk from wildfires

Traditionally we have used US Census block density (housing units) to develop density maps for WUI definition

Higher spatial resolution is desirable

Sources

Structures USA

10,931,401 buildings

Oak Ridge National Laboratory (ORNL)

Federal Emergency Management Agency (FEMA) Geospatial Response Office

Microsoft Building Footprints

12,886,951 buildings

The 2018 and 2020 Microsoft non-overlapping building footprints were merged to create a composite dataset and building footprint data was added from counties where available.

Comparisons

Buildings USA (FEMA / Oak Ridge NL / USGS)

- Commercially available satellite imagery
- Buildings >450 sq feet
- Occupancy type from Census Housing Unit data, HIFLD, LightBox parcels and modeling.
- For Flood Insurance Mitigation, Emergency Preparedness and Response
- Maintained over time

MS Footprints

- From Bing Maps imagery using deep learning object classification methods
- Building outlines only
- For urban planning and risk assessment

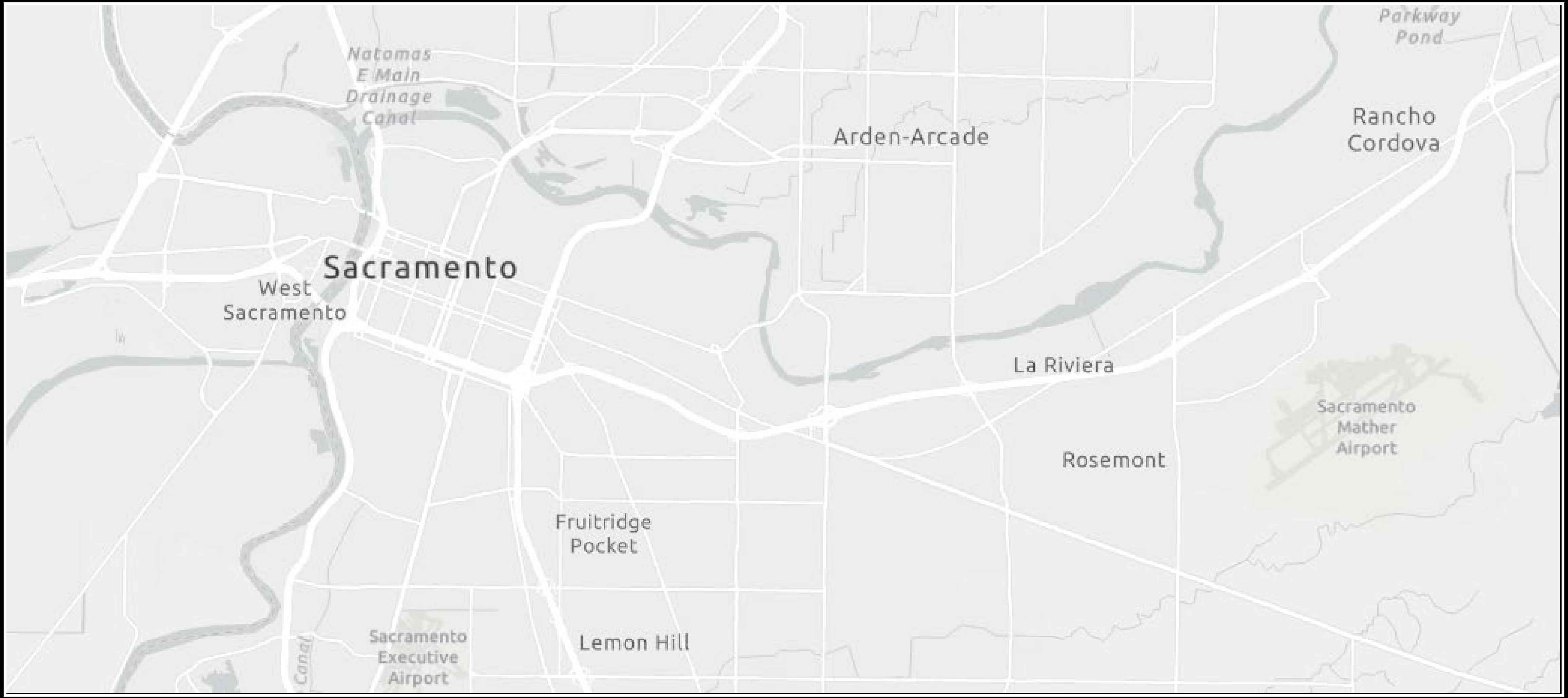
Occupancy Class

OCC_CLS

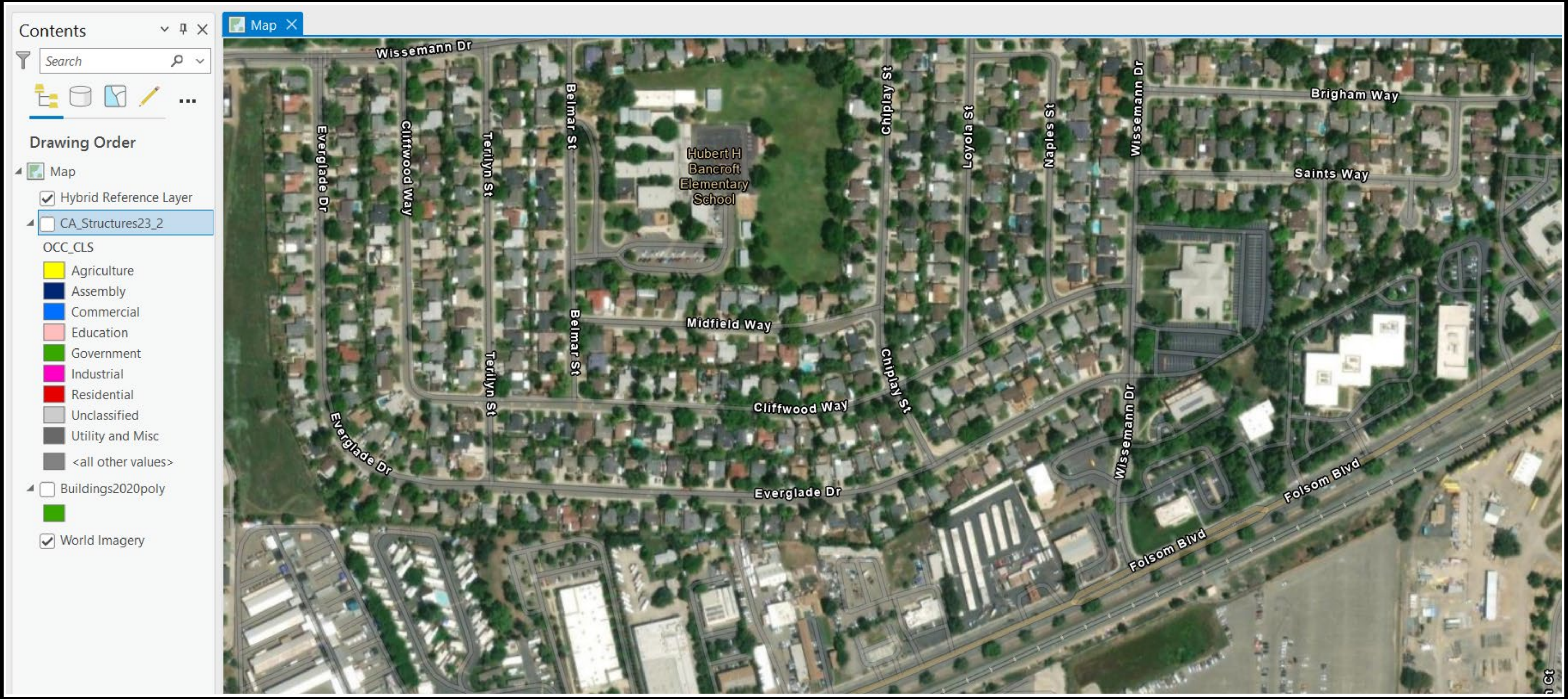
Structures USA (CA)

OCC_CLS	Records	Percent
Agriculture	119,372	1%
Assembly	33,494	0%
Commercial	317,529	3%
Education	64,217	1%
Government	73,980	1%
Industrial	142,333	1%
Residential	9,901,603	91%
Unclassified	272,246	2%
Utility and Misc	6,627	0%
	10,931,401	100%

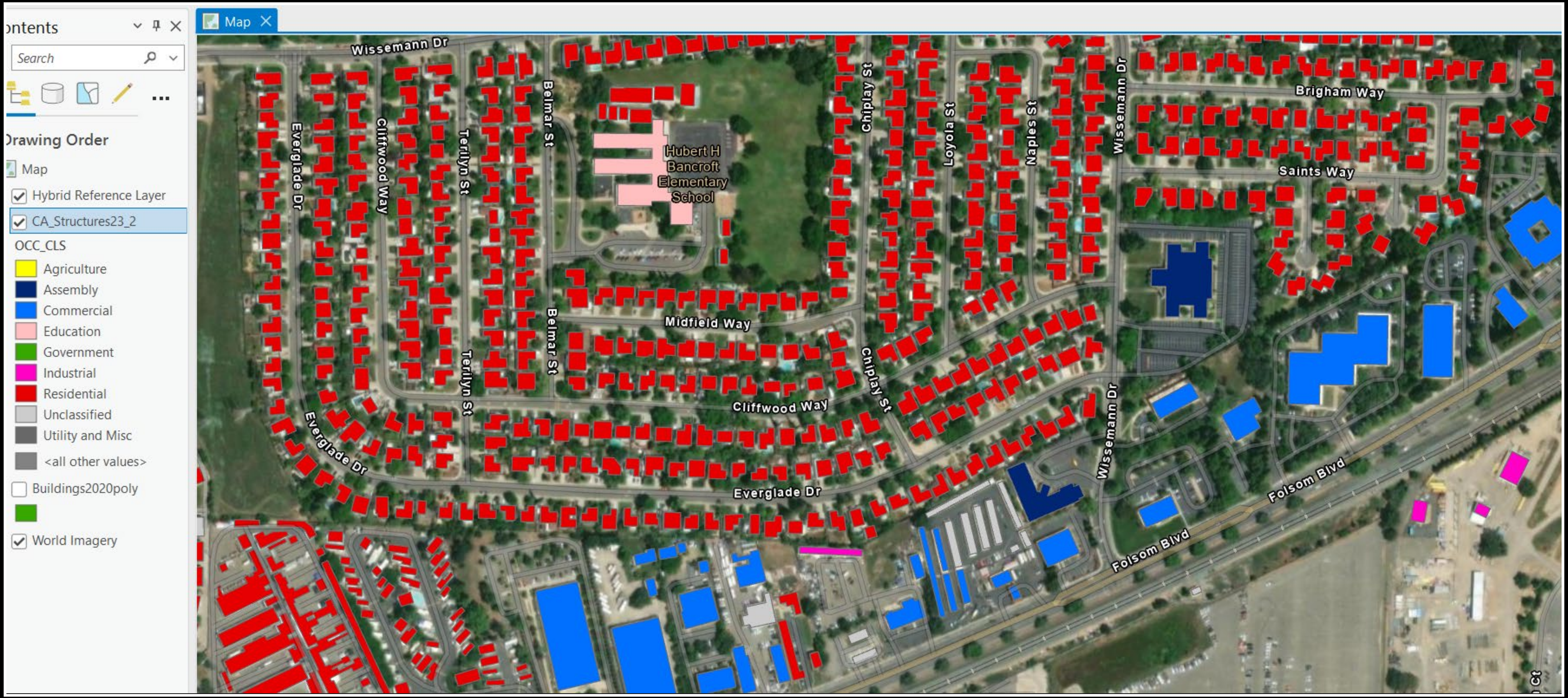
	PRIM_OCC	Count
1	Agriculture	119,372
2	Aviation	1,423
3	Banks	17
4	Colleges/Universities	17,838
5	Community Center	8,498
6	Construction	1,109
7	Convention Center	427
8	Emergency Response	4,215
9	Energy Control Monitoring	521
10	Entertainment and Recreation	30,802
11	Food/Drugs/Chemicals	8,004
12	General Services	45,272
13	Ground	3,416
14	Heavy	7,972
15	High Technology	1,343
16	Hospital	2,395
17	Indoor Arena	597
18	Institutional Dormitory	4,911
19	Light	115,563
20	Manufactured Home	418,422
21	Marine	1,242
22	Medical Office/Clinic	8,727
23	Metals/Minerals Processing	8,357
24	Multi - Family Dwelling	1,172,700
25	Non-Civilian Structures	24,507
26	Nursing Home	7,949
27	Other Educational Buildings	9,728
28	Parking	3,697
29	Personal and Repair Services	37,378
30	Pre-K - 12 Schools	36,559
31	Professional/Technical Services	69,581
32	Rail	95
33	Religious	23,830
34	Retail Trade	151,873
35	Single Family Dwelling	8,275,106
36	Stadium	124
37	Temporary Lodging	22,569
38	Theaters	414
39	Unclassified	272,246
40	Veterinary/Pet	754
41	Wholesale Trade	11,848
	ALL	10,931,401



Zooming into an urban area….

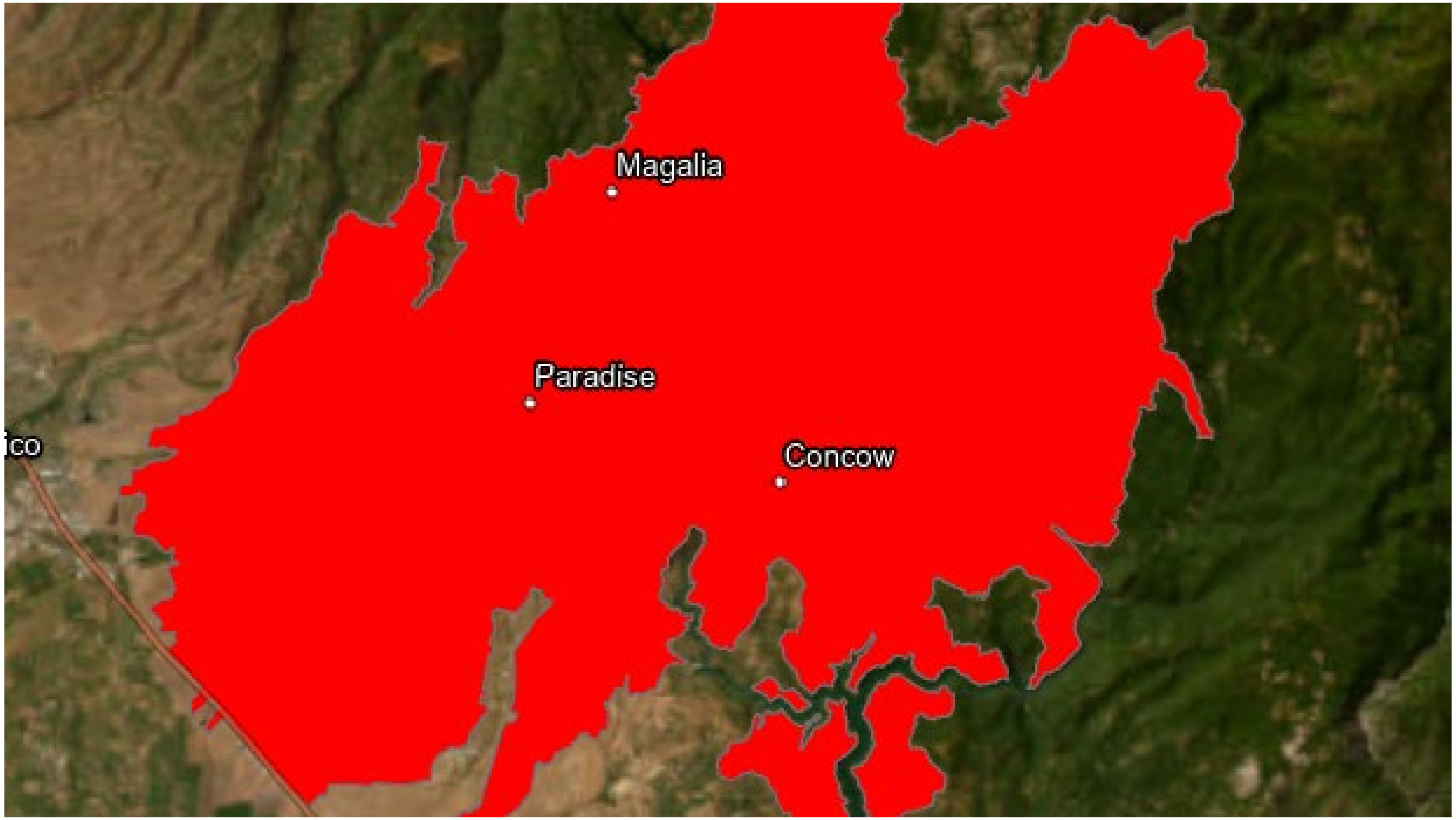


Structures USA (CA) – Urban Area

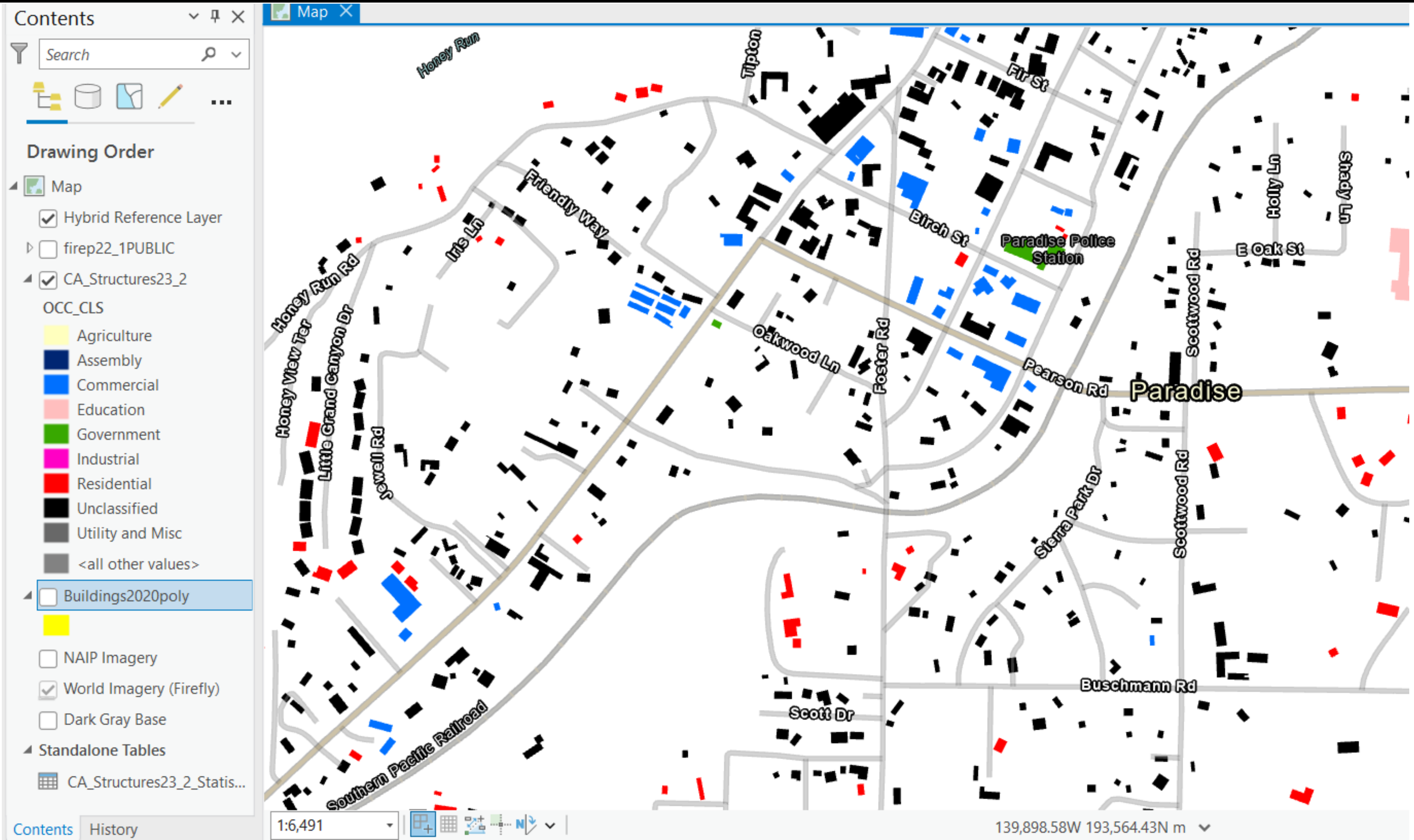


Structures USA (CA) Urban Area

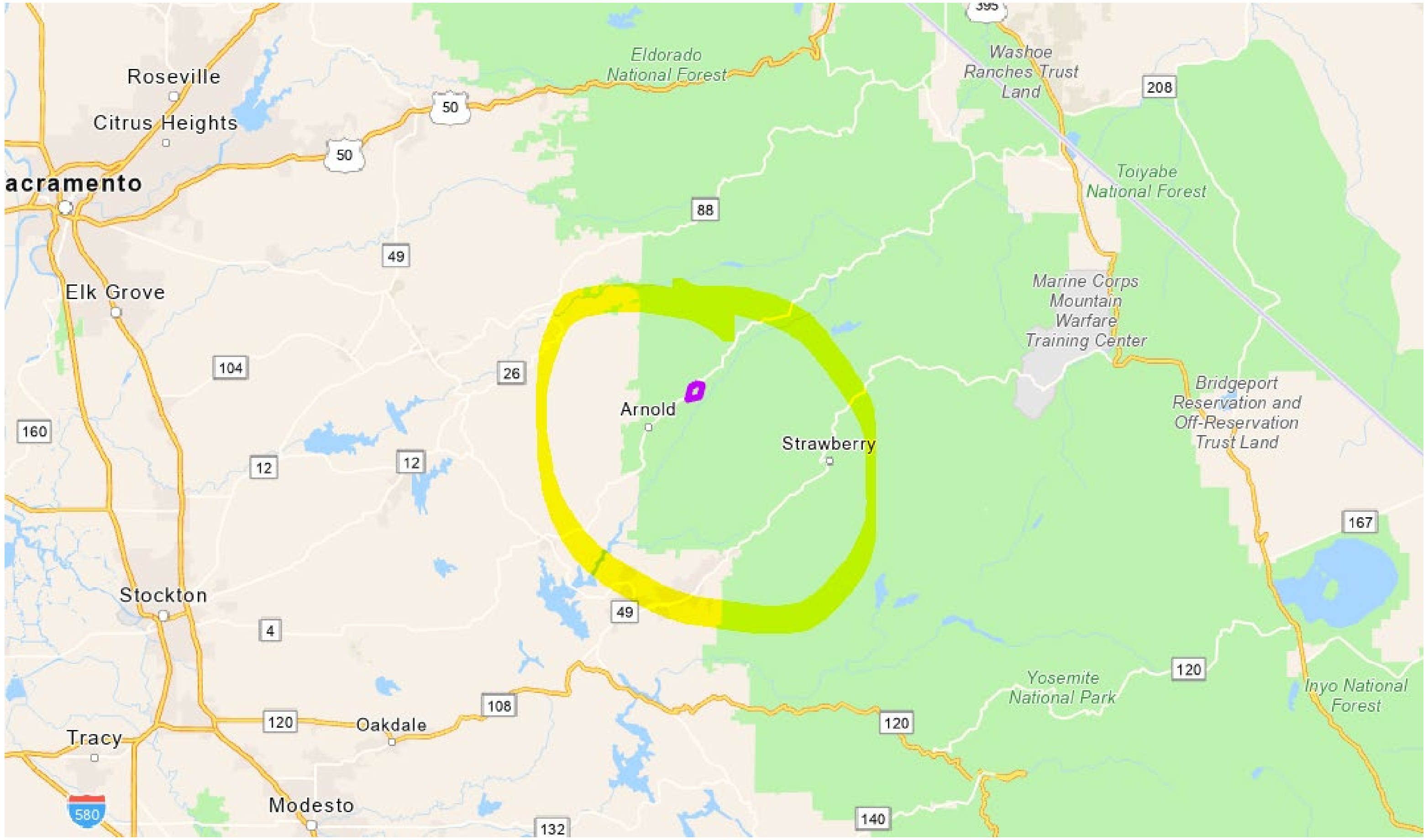
Camp Fire – Paradise (Nov 2018)



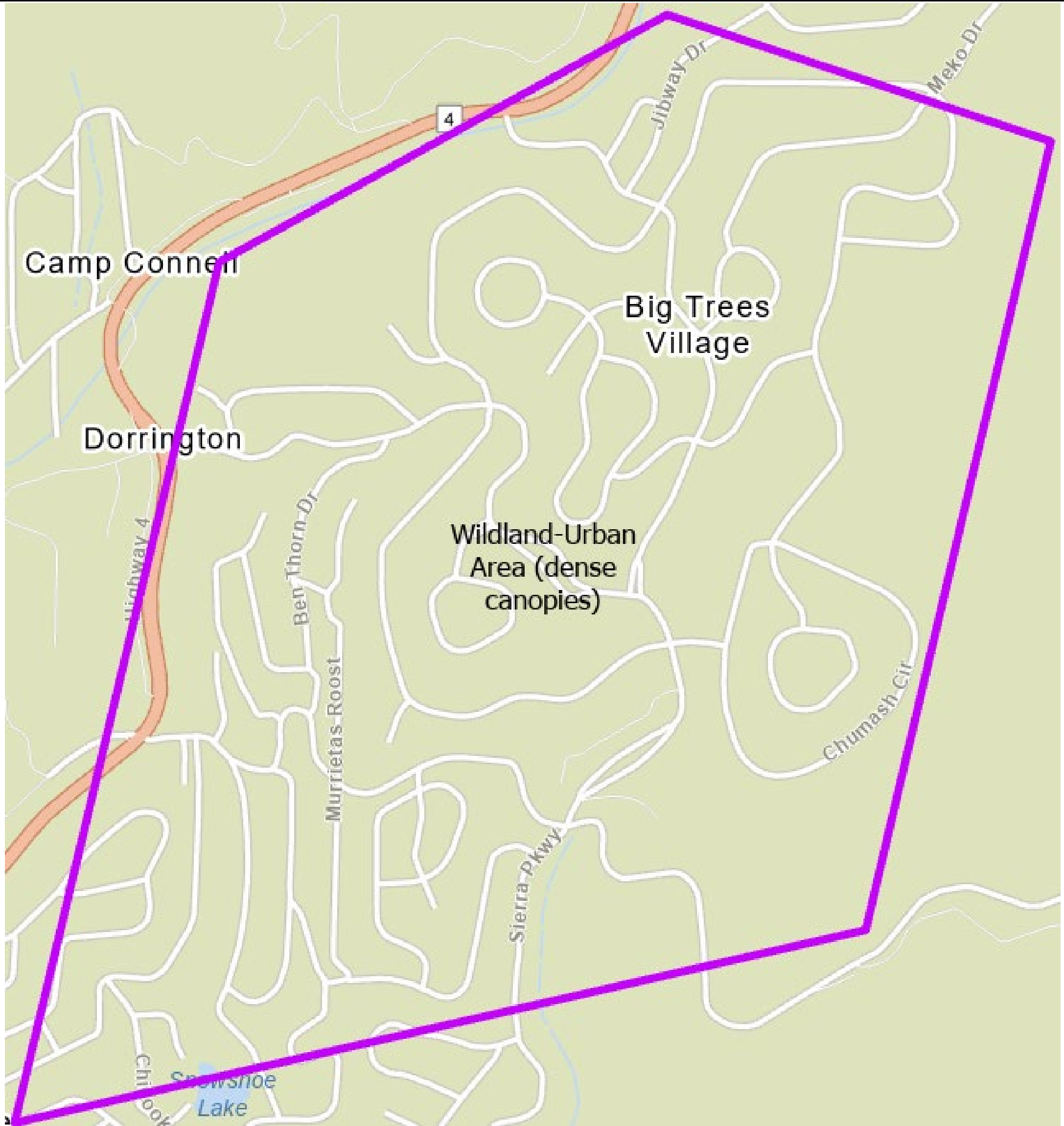
Paradise Fire damaged homes = Unclassified



Comparing datasets – dense overstory

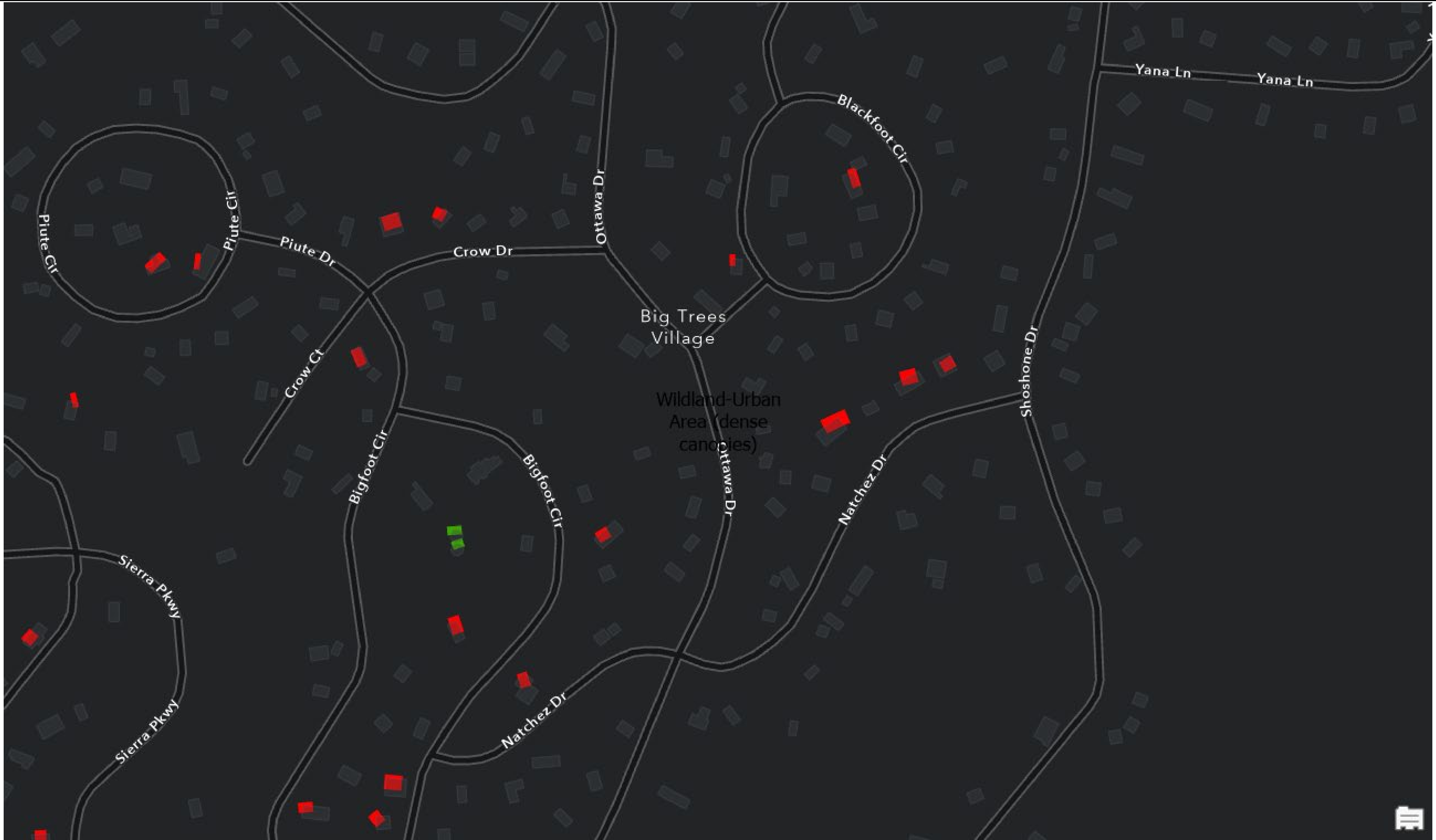


Big Trees

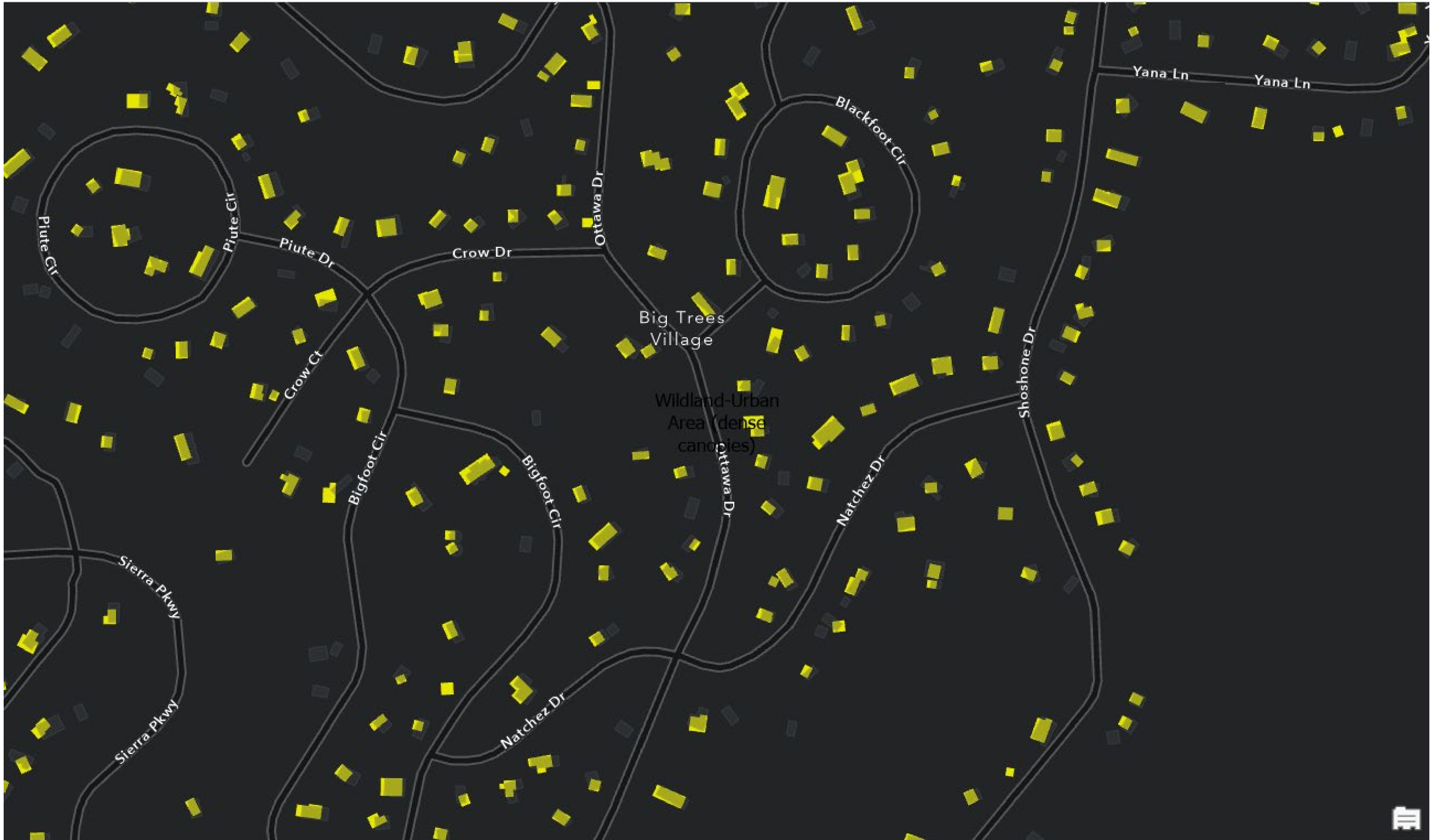


4
Jibway Dr
Meko Dr
Camp Connell
Big Trees
Village
Dorrington
Wildland-Urban
Area (dense
canopies)
Ben Thorn Dr
Highway 4
Murrietas Roost
Chumash Cir
Sierra Pkwy
Snowshoe
Lake

Structures USA



MS Footprints

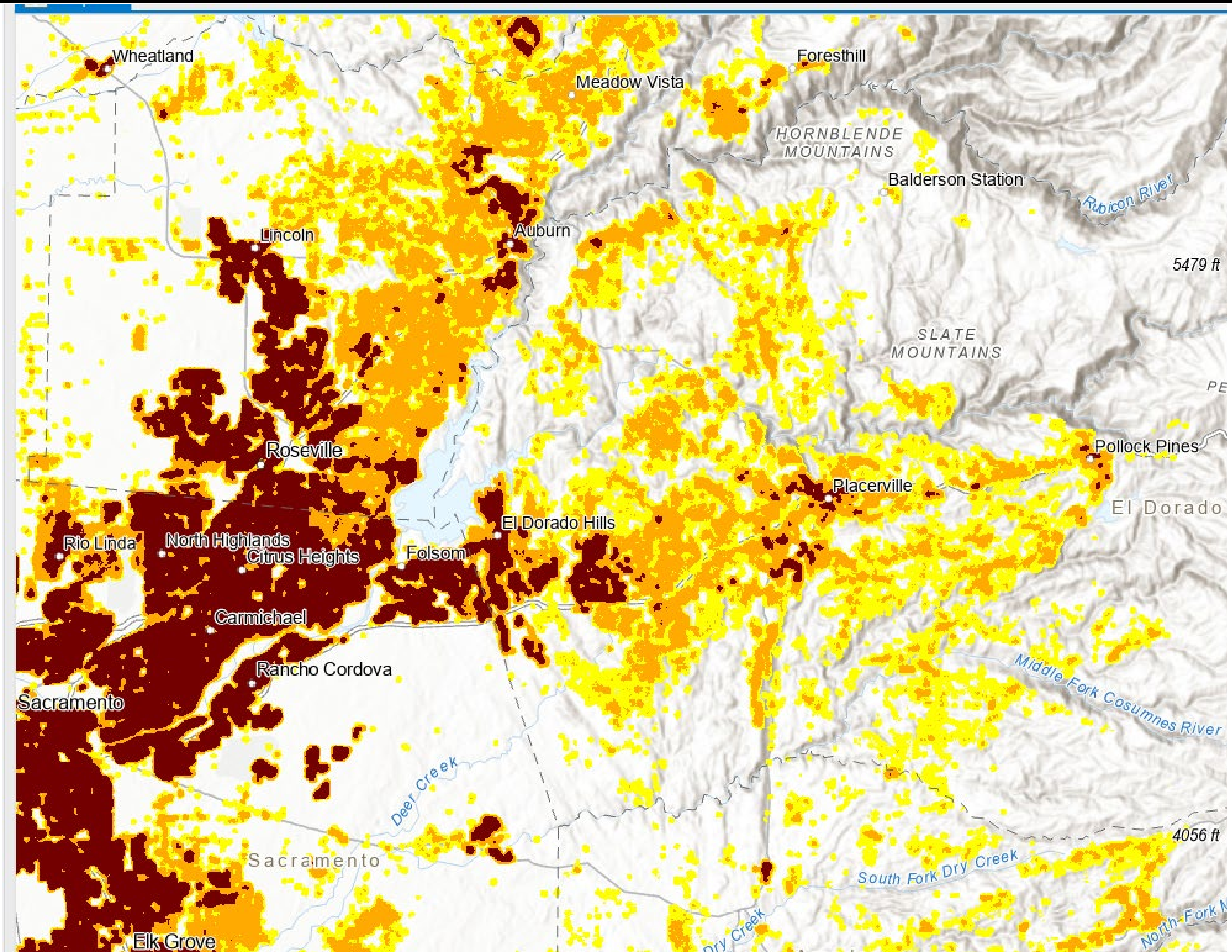


WUI Characterization Input: Residential Density Maps

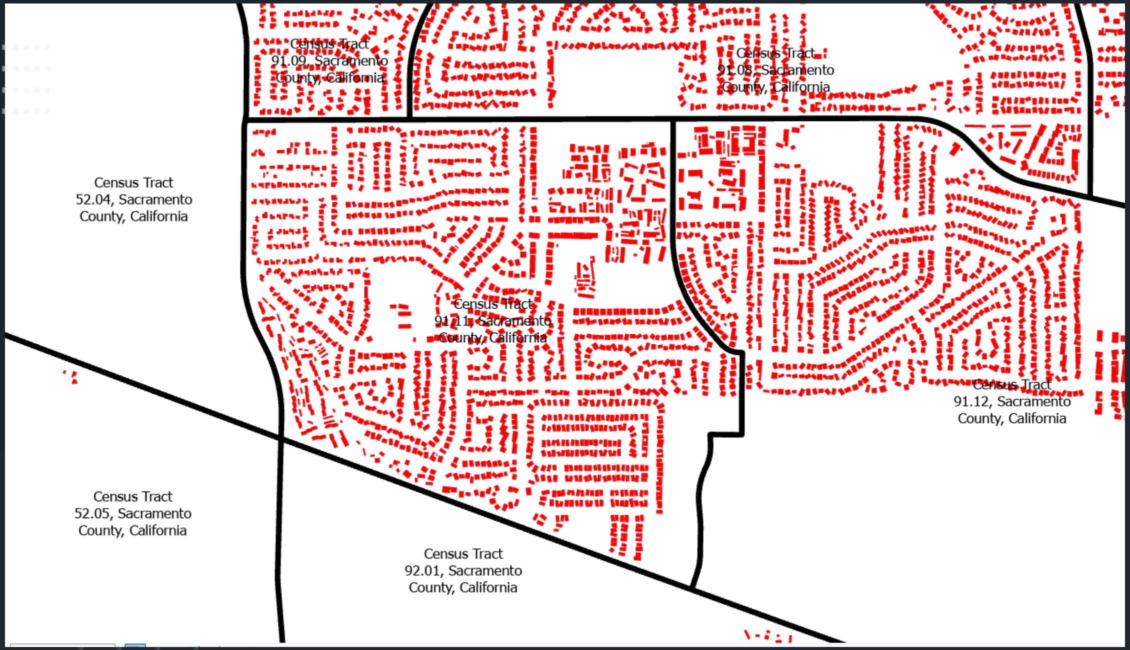
FEMA_Structures_270_DEN4

Value

- <32 RU / SQMI
- >=32 RU / SQMI to 128 RU / SQMI
- >128 RU / SQMI to 640 RU / SQMI
- >640 RU / SQMI



Structures tell only part of the story (e.g. risk to households, populations...)



NAME	Census Tract 91.11, Sacramento County, California
POP2020	5670
PCTChildUnder5	4.3
PCT65Over	13.2
PCTPOVERTY	15.4
PCTNonEnglishLang	31.8
Non_White_Percent_1	54.568966
PCTDisability	21.9
CarOwner_Percent	2

Mapping spatial patterns using Structures USA

- Pros
  - Identify residential structures
  - Updated regularly
  - Endorsed by FEMA
- Cons/Issues
  - Classification problems in rural areas
  - Does not reflect associated population metrics (e.g., housing units)
- Options
  - Enhance the data?
  - Apportion Block-level Census Housing Unit counts to Residential centroids (2020) and ACS for inter-census years?

Thank you!

- Jim Spero, Retired Annuitant
  - Fire and Resource Assessment Program
  - jim.spero@fire.ca.gov
  - 916.337.1375

California Office of Data and Innovation (ODI) &
California Department of Finance (DOF)

California Building Footprints and their use in Small Area Population Estimates

Fennis Reed, Demographic Research Unit, DOF
Ian Rose, Data Services and Engineering, CalData, ODI
Brittany Allen, Data Services and Engineering, CalData, ODI

Today's Agenda

Intro to Small Areas

Building Footprint Dataset

Methodology

Case Study

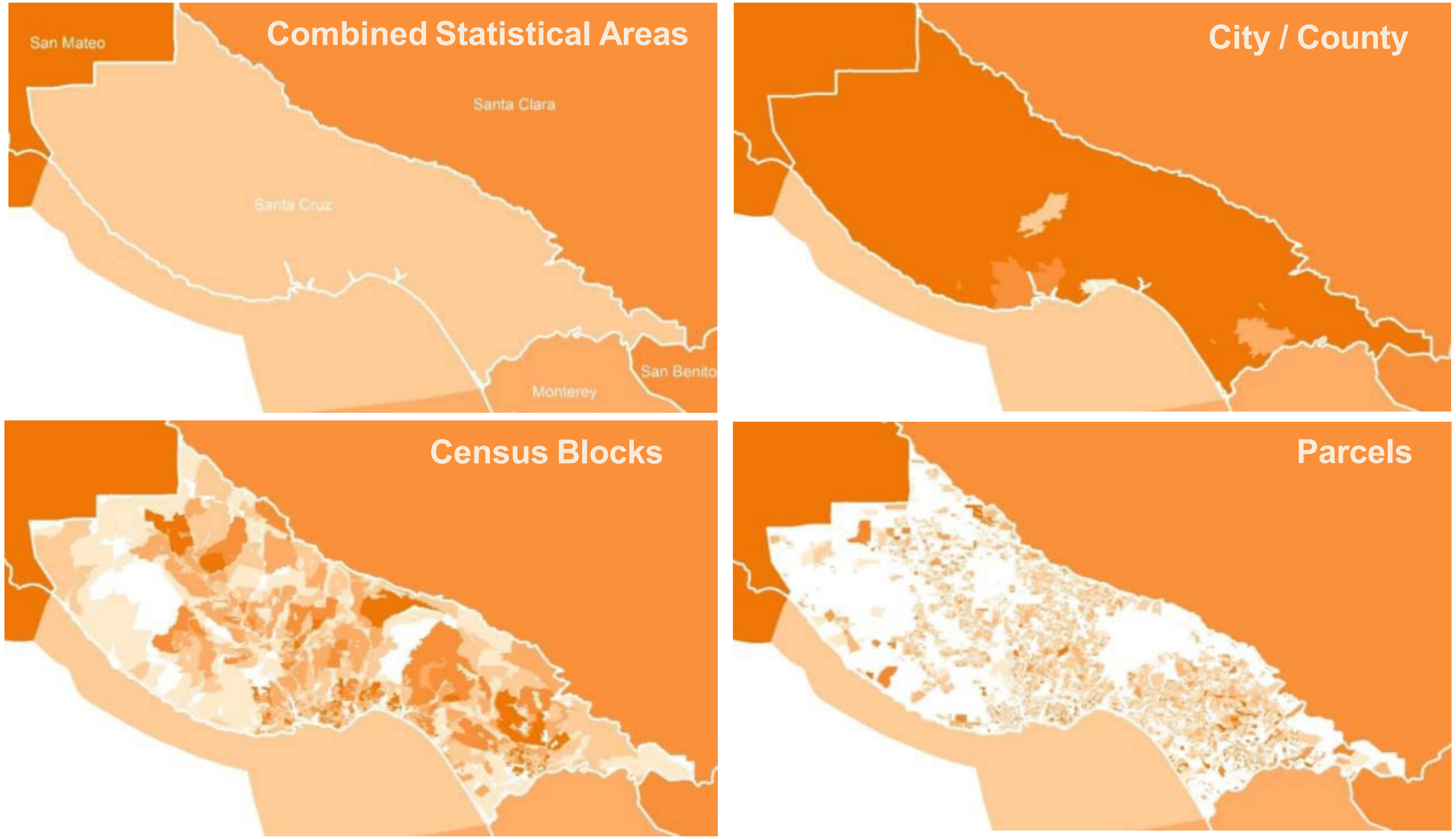
Process Improvement

Small Area Estimation

- **Annual Estimates**
  - State, combined statistical area, County and City scale

- **Special Estimates:**
  - Unique jurisdictions ill-represented by aggregate estimates
    - Water districts
    - Library districts
    - Fire districts
    - Utility service areas

DOF x ODI



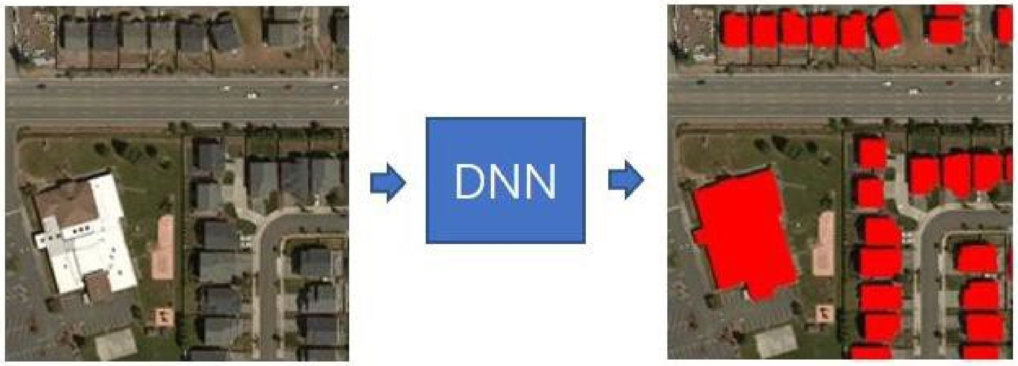
Essential Dataset

Microsoft Building Footprints

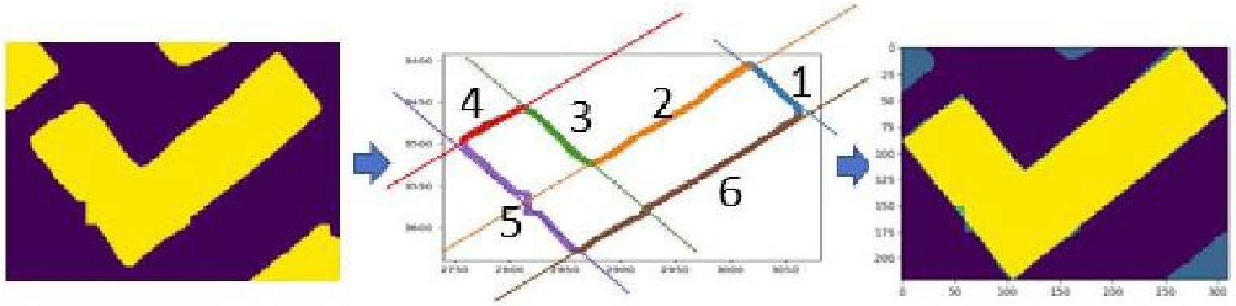
Data source

- US and Global Footprints
- Machine Learning approach to footprint detection

Stage1: Semantic Segmentation



Stage 2: Polygonization



US Footprints

Global Footprints

Essential Dataset

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- US and Global Footprints
- Machine Learning approach to footprint detection

Challenges

- Global dataset receives updates
- Unintuitive and large downloads
- No index of footprints

US Footprints

Global Footprints

Essential Dataset

Microsoft Building Footprints

Data source
- US and Global Footprints
- Machine Learning approach to footprint detection

Challenges
- Global dataset receives updates
- Unintuitive and large downloads
- No index of footprints
- Errors of inclusion and exclusion

Benefits
- Freely available
- Perform better than comparable projects

US Footprints

DOF x ODI

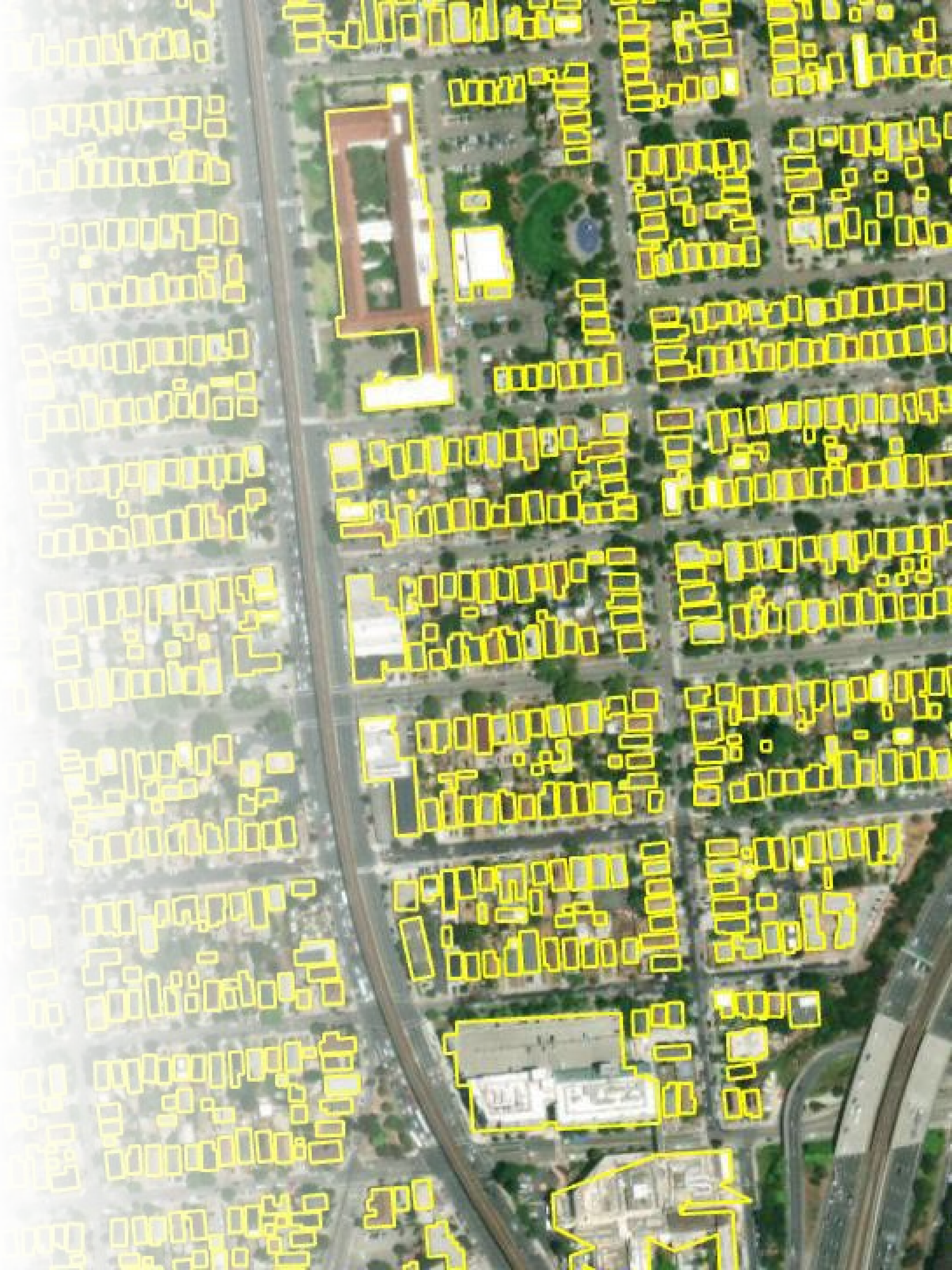
Global Footprints

Integration Problems with

Microsoft Building Footprints

- Hosted in non-intuitive platform as large files
- Dataset updates are inefficient on local hardware
- Revisions made with each new update are lost
- Manual reconciliation with Census geometry
- Time consuming parcel x footprint reconciliation

DOF x ODI

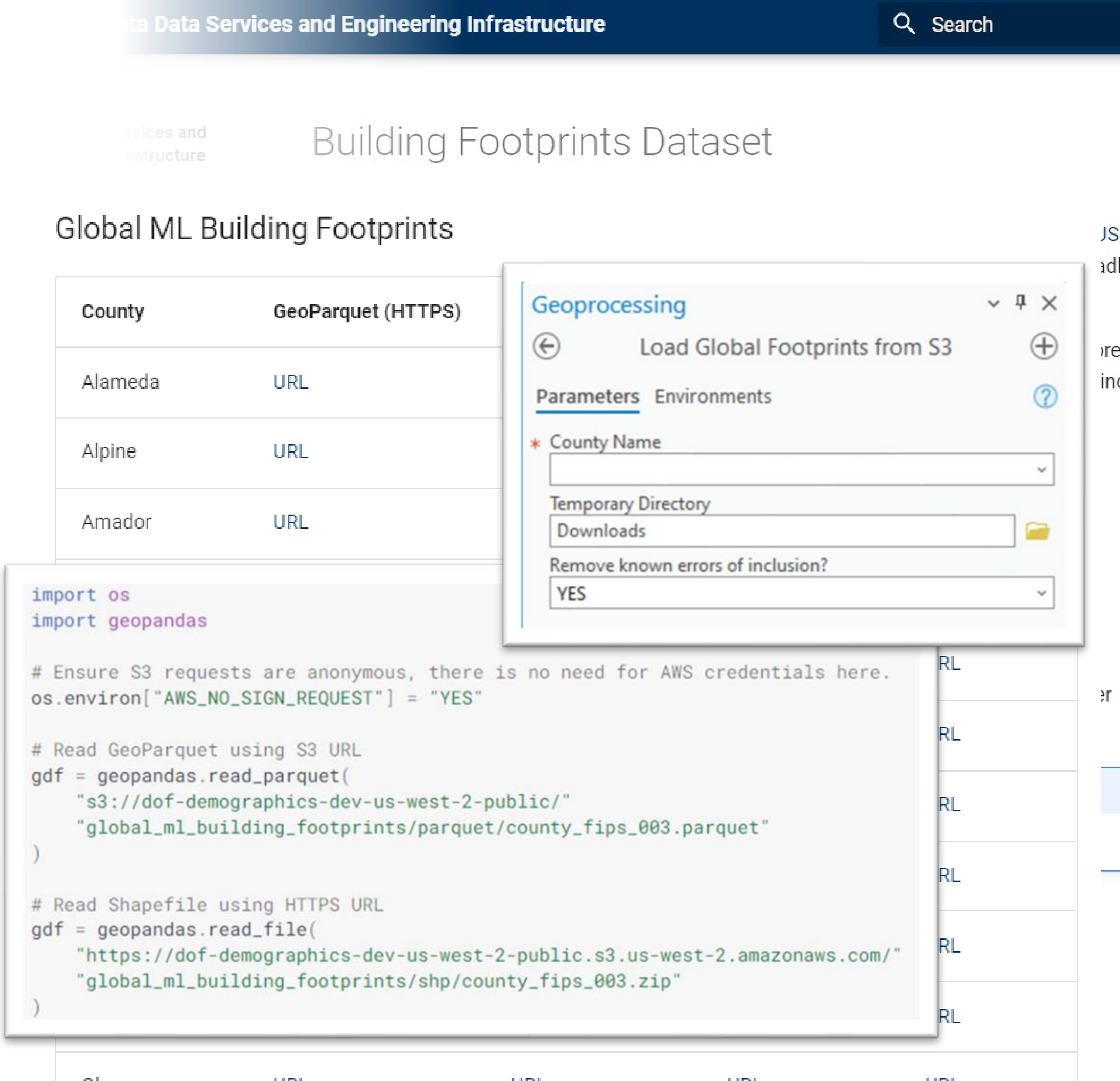


An Innovative Solution

California Building Footprints

- Collaboration with ODI CalData and Department of Finance
    - Data and Innovation Fund
        - Modern Data Stack Accelerator

- Same data, different ways to access:
    - URLs
    - Python-based workflow
    - ESRI ArcPro Toolbox



DOF x ODI

https://cagov.github.io/data-infrastructure/data/footprints/

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- Added value
  - Census TIGER lines

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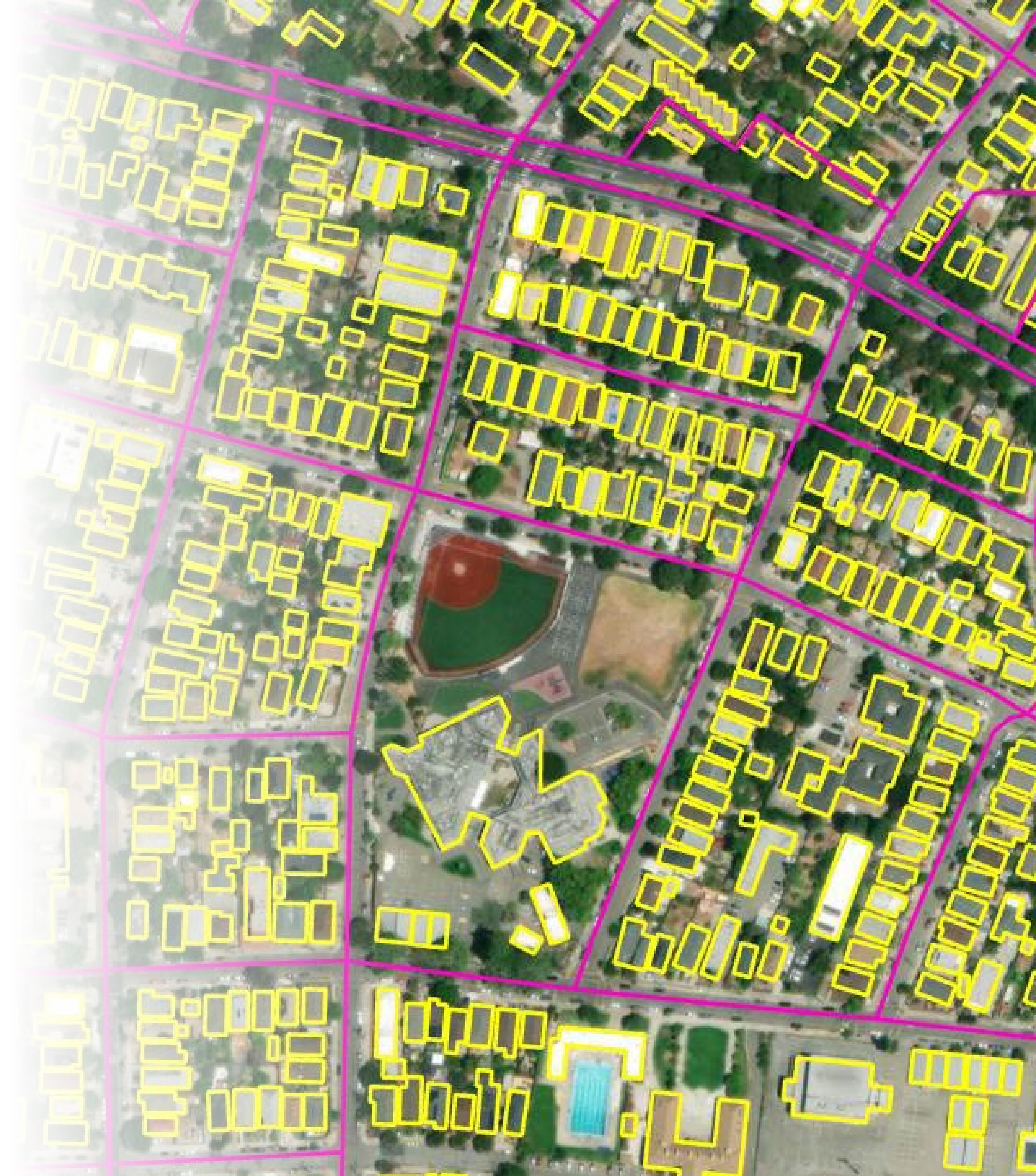

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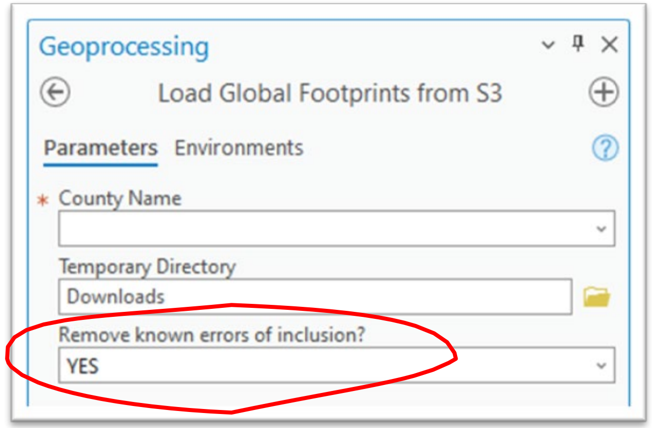
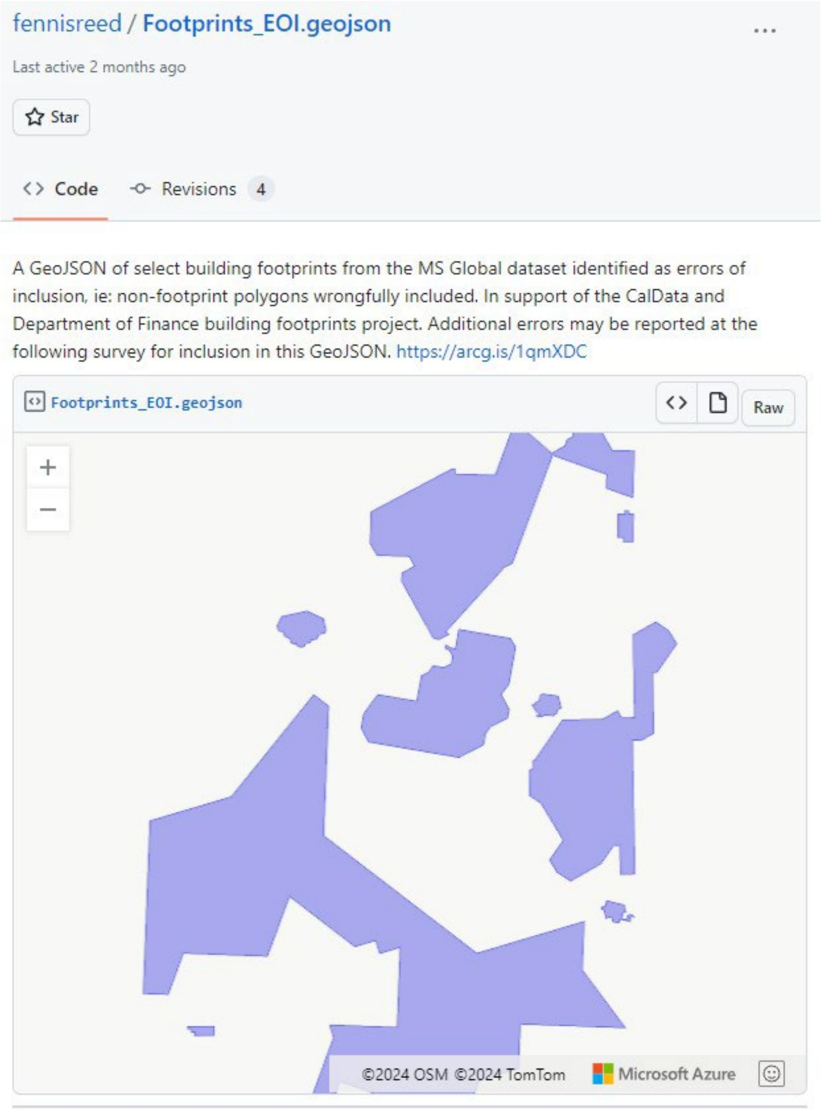
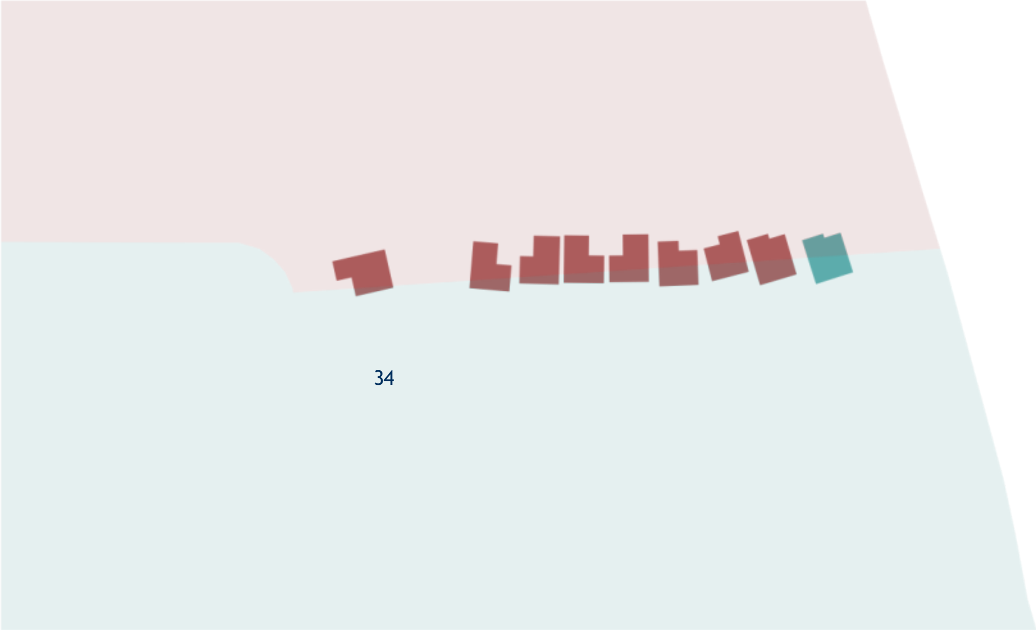




https://cagov.github.io/data-infrastructure/data/footprints/

Joining with Census TIGER data

- Original footprint dataset doesn't have much detail or metadata, it's just a big list of shapes
- As part of our data pipeline, we partition by county and enrich with Census TIGER shapes
- If a footprint intersects more than one geometry, assign it to the geometry with a bigger overlap
- Allows for more efficient reads of the data:
  - Only read the counties you need
  - Only read the columns you need*
  - Only read the census geometries you need*



* GeoParquet only

File formats (everyone's favorite topic)

- Stored in a public AWS S3 bucket, anyone can download them
  - Cheap, reliable, fast
  - API access as well as HTTP download URLs
- Delivered in both GeoParquet and zipped Shapefile formats

	GeoJSON (original)	Zipped Shapefile	GeoParquet
Efficient storage	✗	✓	✓
Cloud-friendly	✗	✗	✓
Sensible data types	✗	!	✓
Universally supported	✓	✓	!

Method Overview

- Conceptual framework
- Foundational model
- Adapted model

Dasymetric Mapping

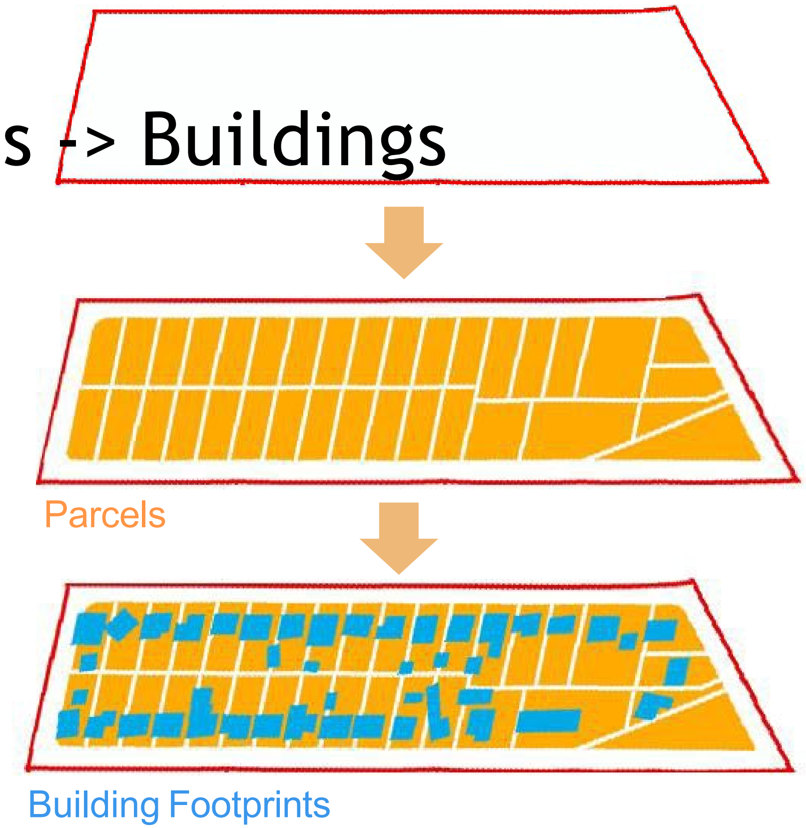
Definition: a method for refining coarse data with ancillary information about the distribution of the variable.

- Assumption:
- County -> Blocks -> Parcels -> Buildings

- Problem:
- Incongruent geometry

DOF x ODI

Expectation:



Reality:

Dasymetric Mapping

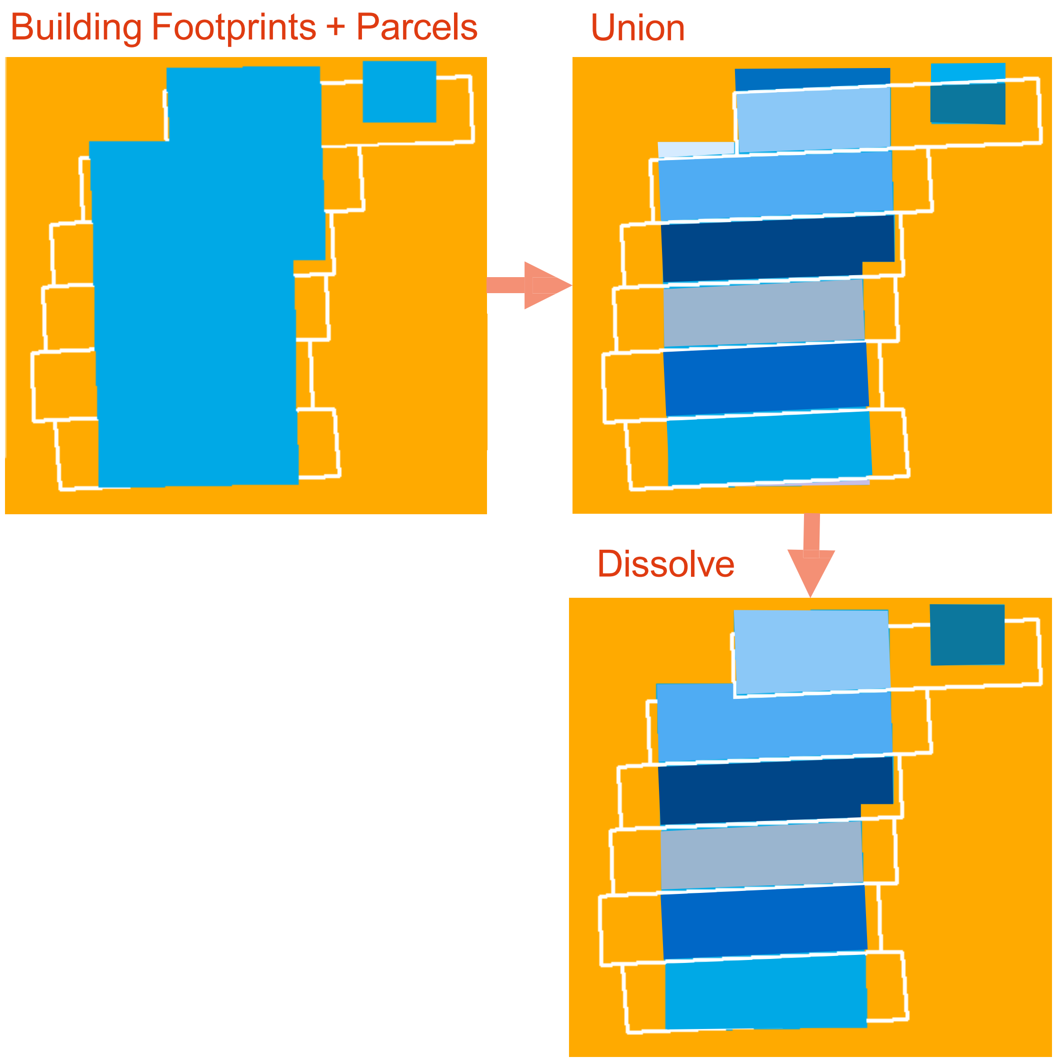
Assumption:
County -> Blocks -> Parcels -> Buildings

Problem:
Incongruent geometry
Previously normalized for the whole state

Solution:
Toolbox to enable the integration of census, parcel, and footprint information on the fly

- Threshold parameters
  - Number of intersections
  - Minimum area
  - Percent contribution

DOF x ODI



Cadastral Expert Dasymetric System (CEDS)

Foundational Method

- Top-down, dasymetric population model
- Distributes larger unit down to Parcels by:
  - Residential area
  - Residential units
- Selects minimal difference to finest unit
- Applies method to larger unit

DOF x ODI

<u>Florida has great data!</u>

(Strode, G., V. Mesev, J. Maantay. 2018, Maantay, J.A., A.R. Marko, C. Hermann. 2007)

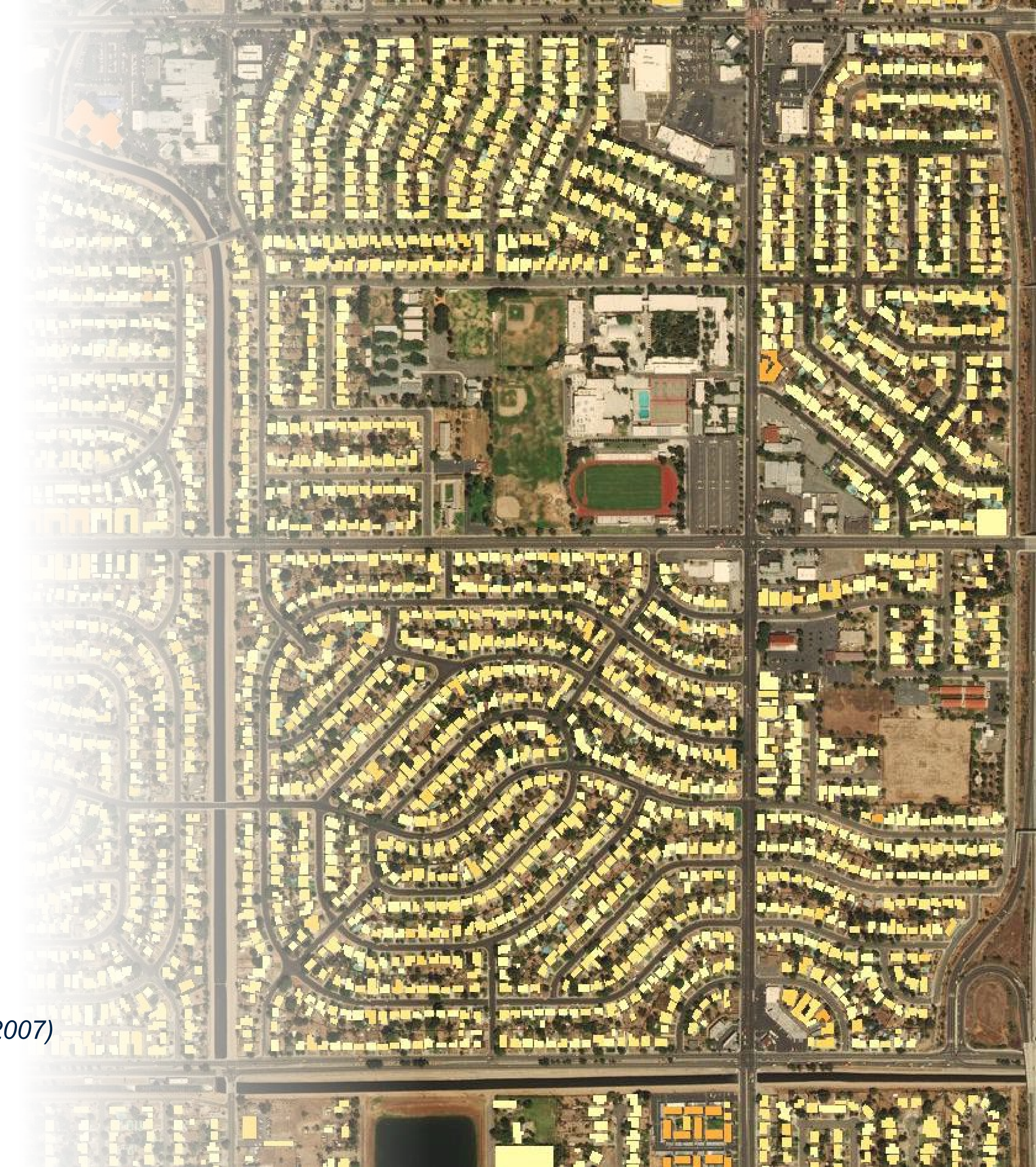
Adapted Method

Additions to the Model

- American Community Survey inputs at different scales
- Building footprint mask
- Specific group quarters allocation
- Disaster response incorporation
- City / County adjustment

DOF x ODI

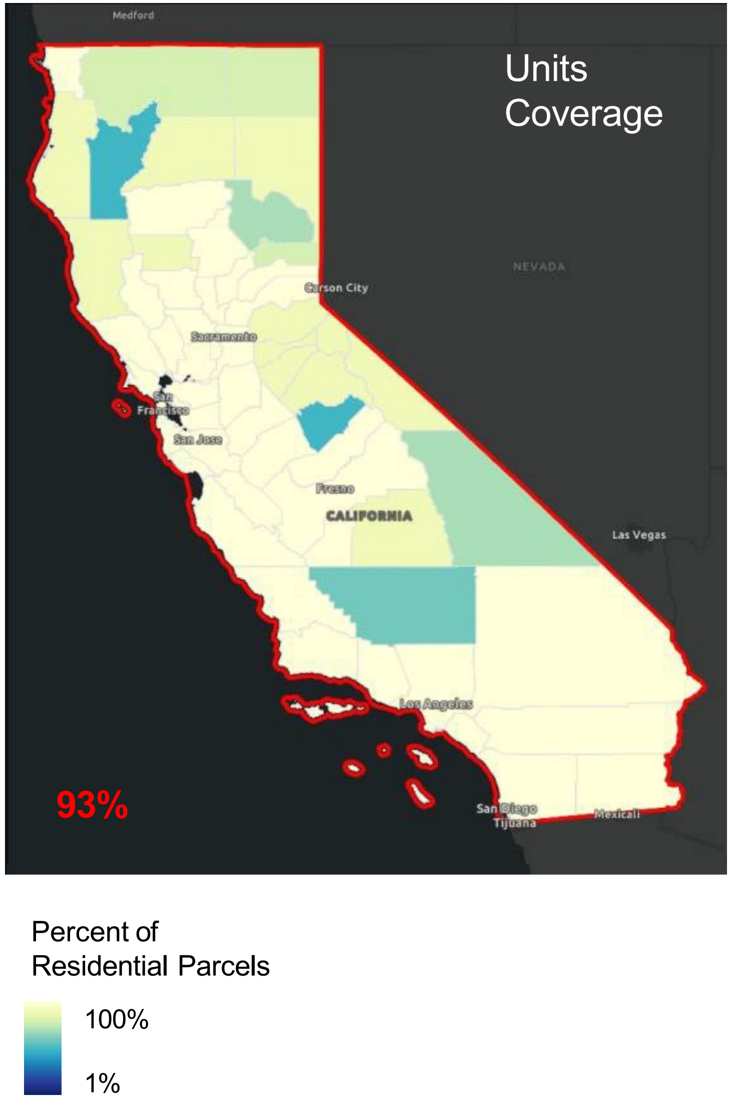
(Strode, G., V. Mesev, J. Maantay. 2018, Maantay, J.A., A.R. Marko, C. Hermann. 2007)



Expanded Variable List

- Residential units
- Residential area
- Building footprint area
- Parcel area
- Bedrooms
- Estimate of Housing Unit Density

- Incomplete coverage
- Augment units and area
  - HCD APR
  - Housing Unit Survey
  - Assessor's use codes

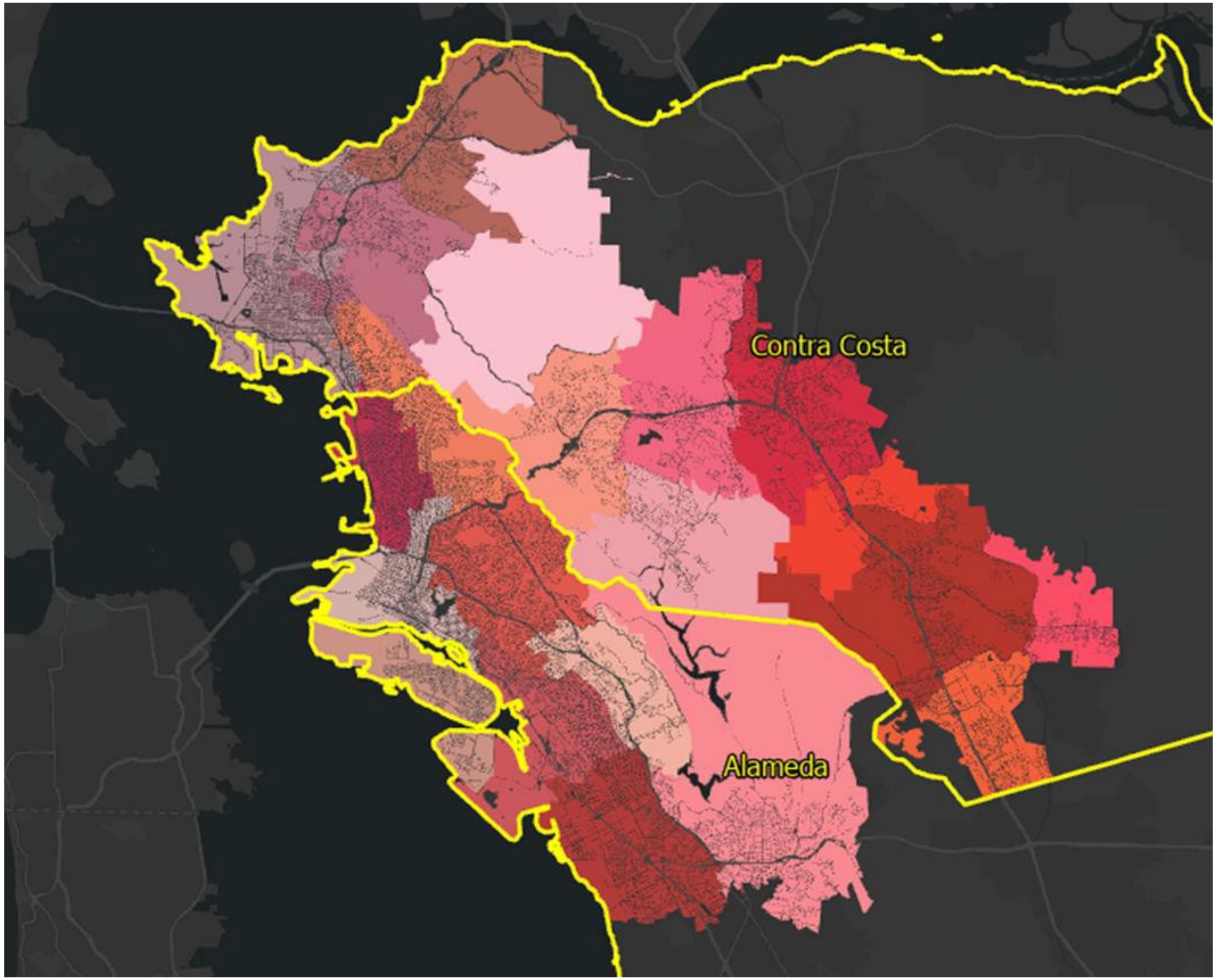


Case Study

East Bay Municipal Utility District, 2023

- Water demand projections
- 21 unique zones
    - Intersects
        - 2 Counties

DOF x ODI



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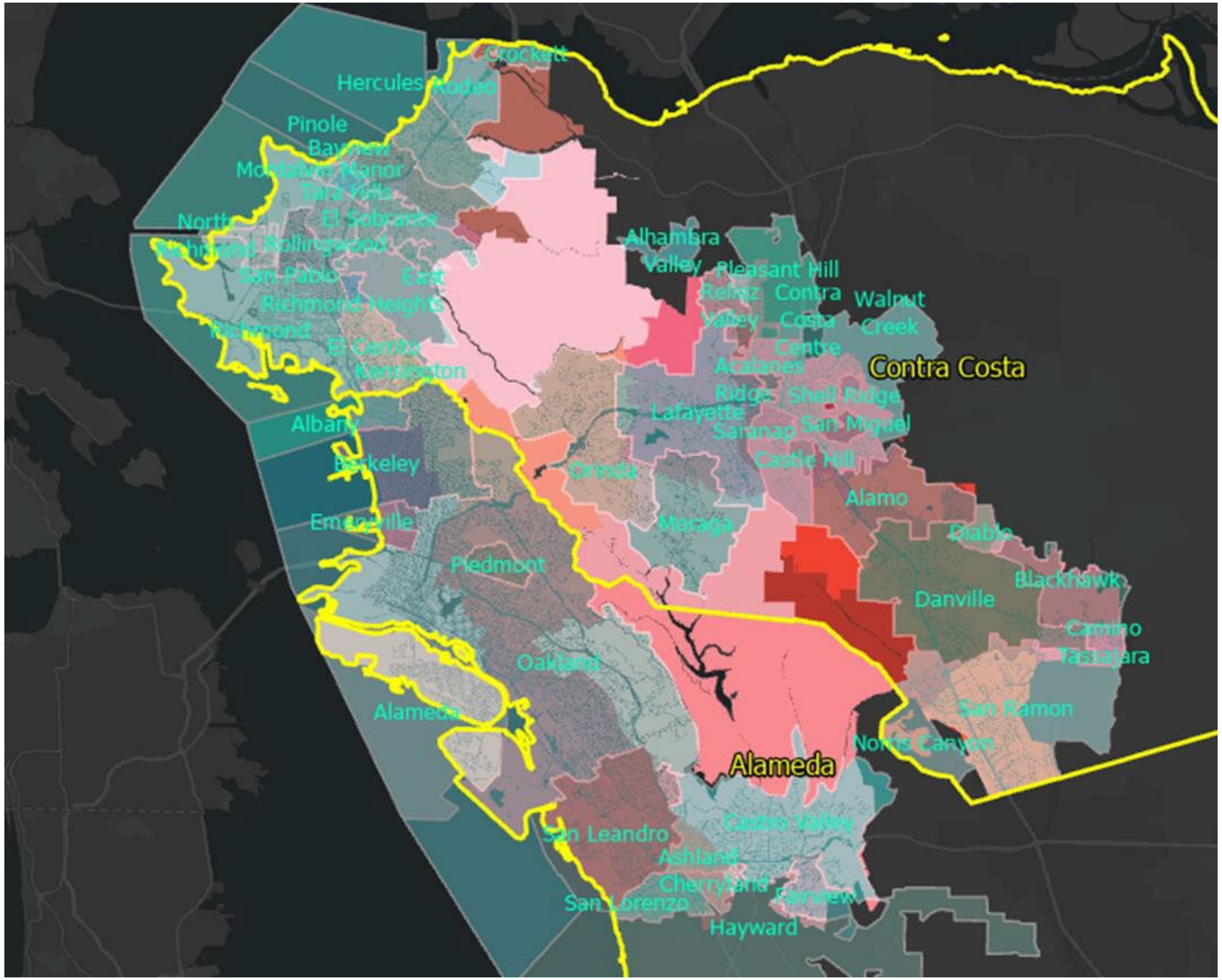

DOF x ODI

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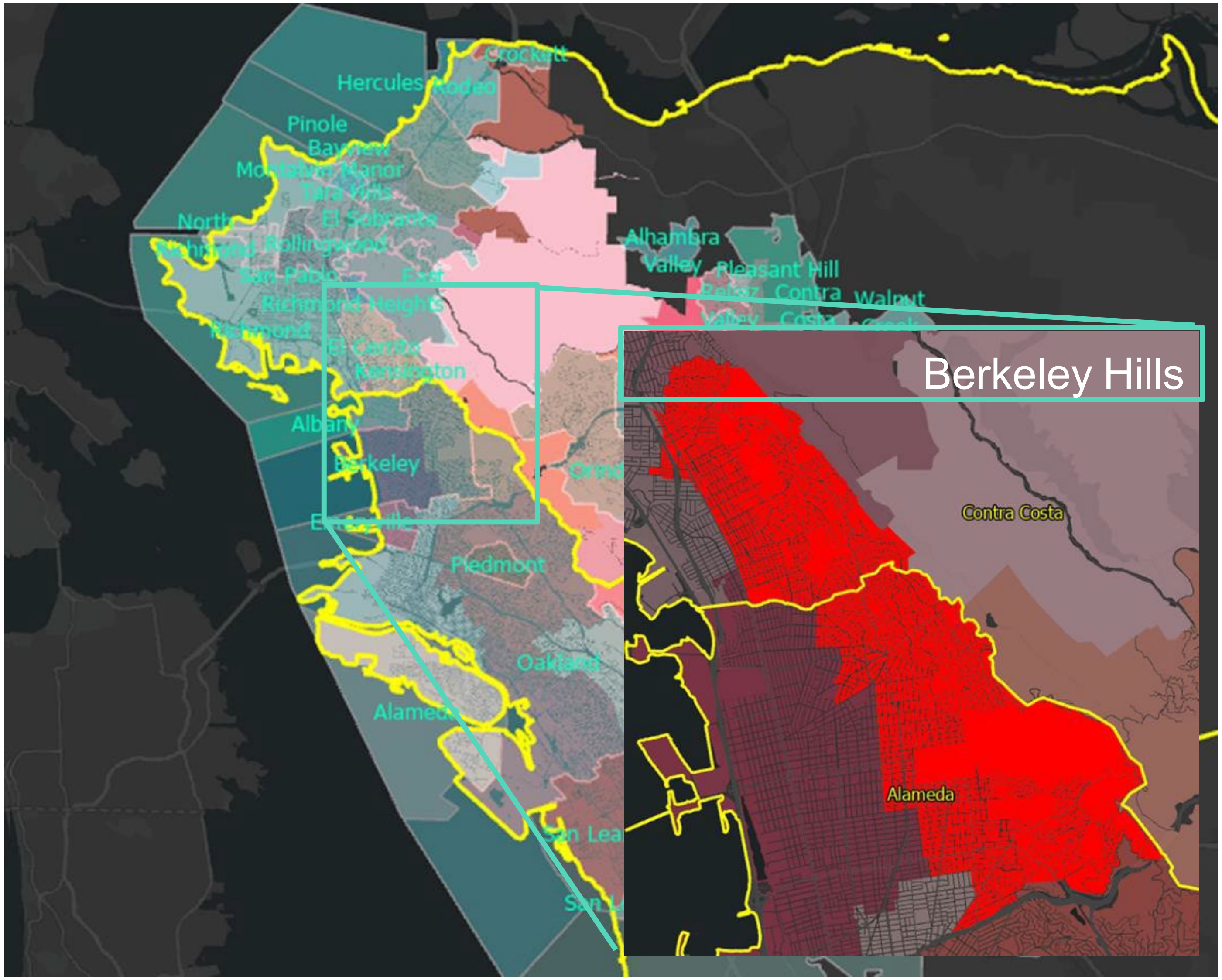

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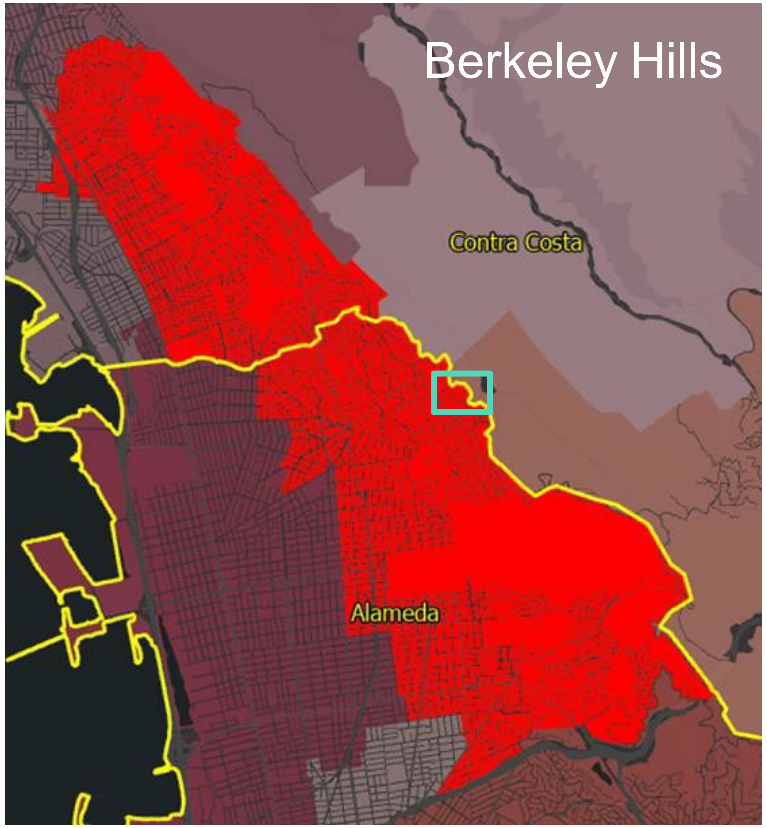
- ACS Housing Range
  - 33,139 – 51,695

DOF x ODI



Populated
Un-populated

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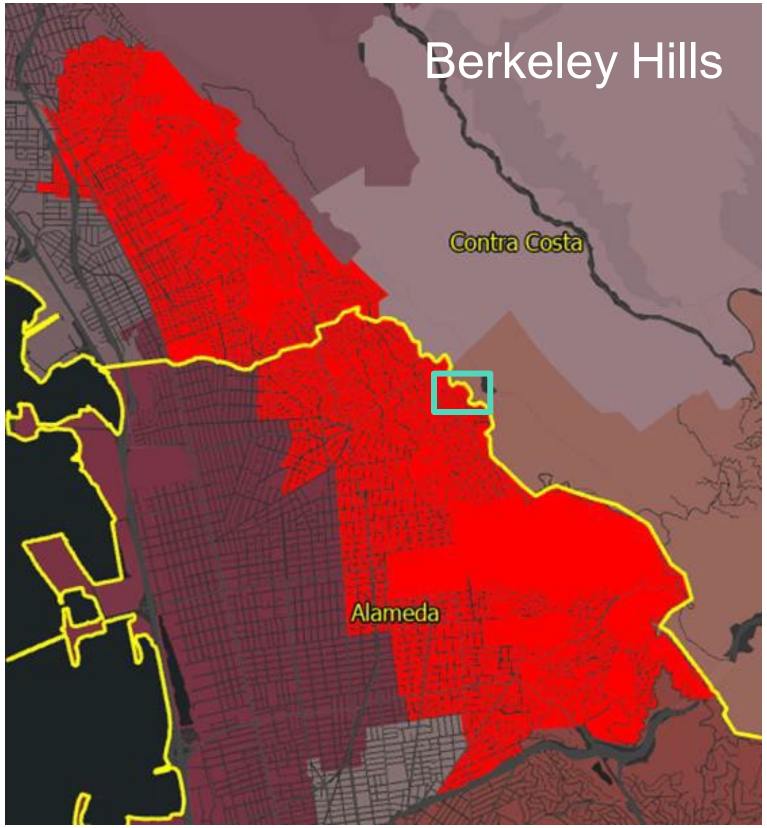

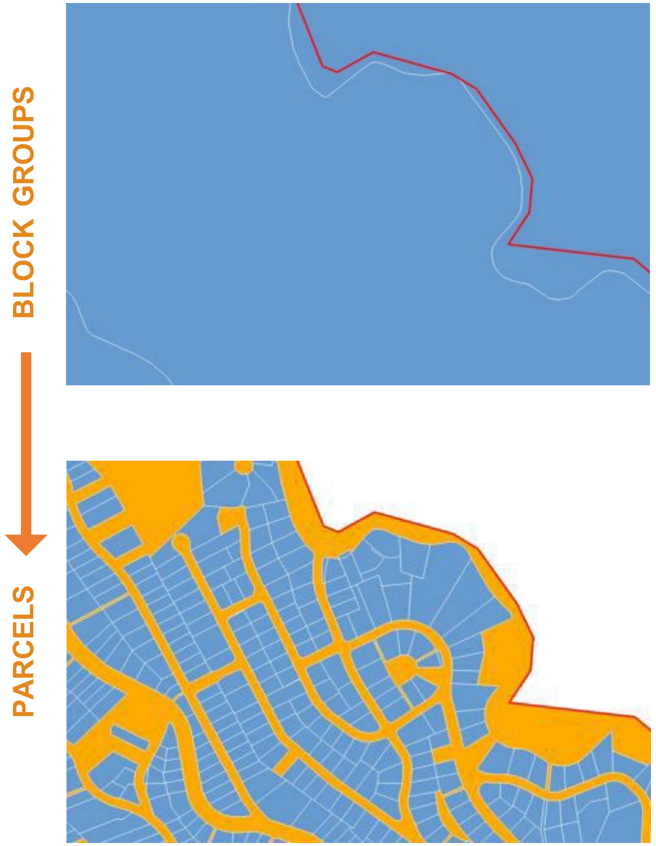

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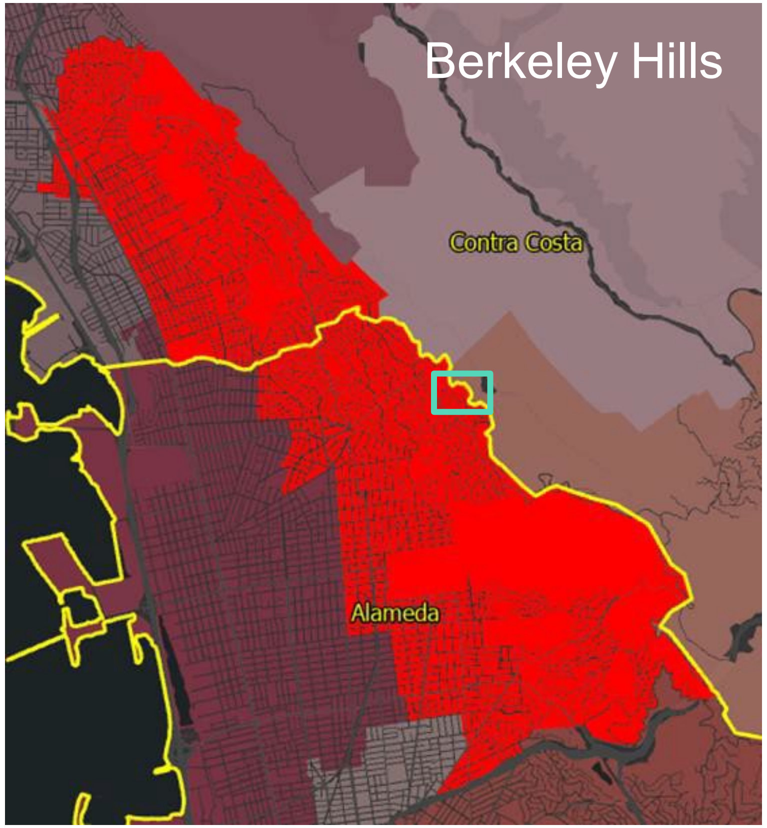
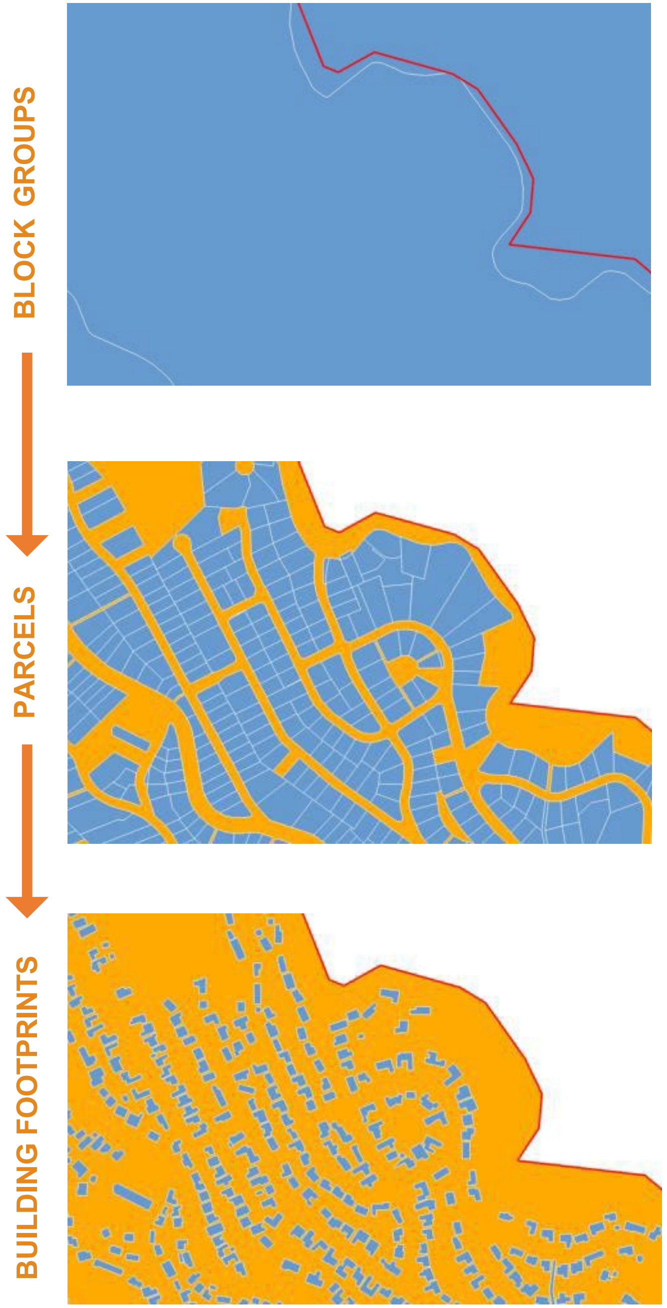
- CEDS Estimate: 43,509
    - Alameda: 30,708
    - DOF x ODI Contra Costa: 12,801
        - Richmond: 337





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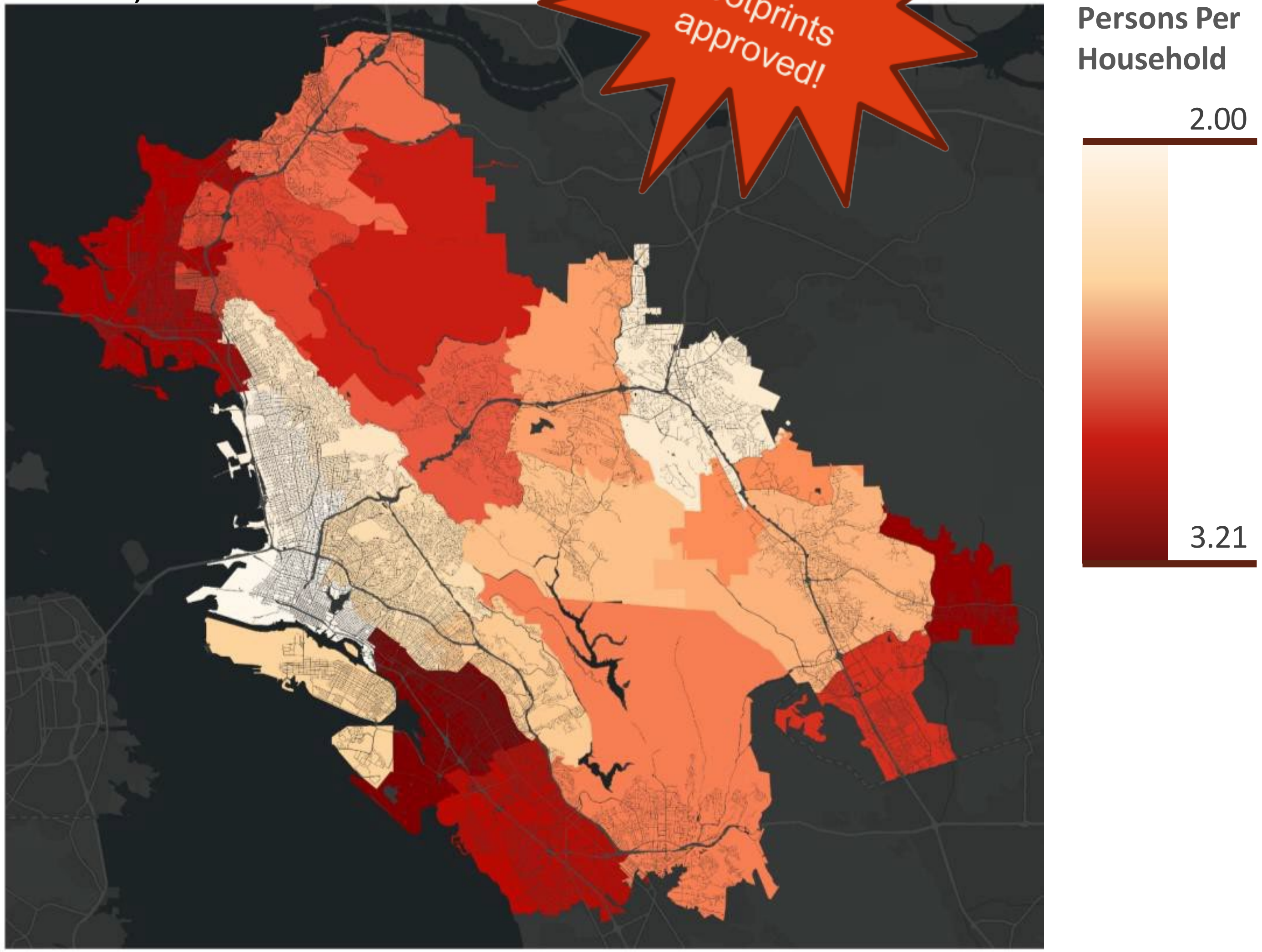
DOF x ODI

- Unique PPH and housing for each zone



Integration Solutions for

Microsoft Building Footprints

🚫 Hosted in non-intuitive platform as large files

✅ Publicly available for granular download with multiple accessible methods

🚫 Dataset updates are inefficient on local hardware

✅ Periodic automated update schedule in the cloud

🚫 Revisions made with each new update are lost

✅ Previous revisions can be retained between updates

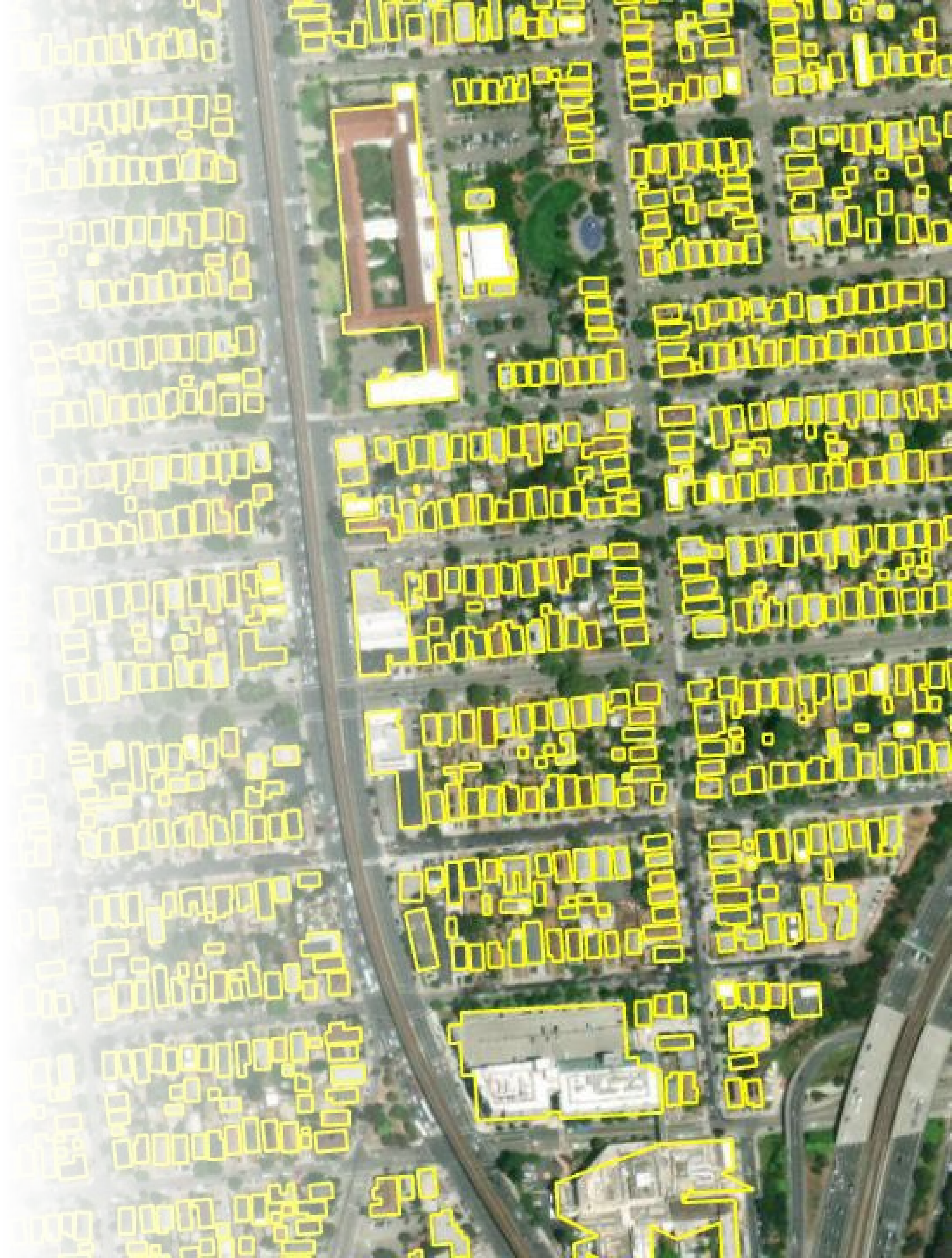
🚫 Manual reconciliation with Census geometry

✅ Calculated automatically with each update

DOF x ODI

🚫 Time consuming parcel x footprint reconciliation

✅ Highly customizable and time efficient



Conclusion

- Footprints are easy to access and use

- Empowers integration with existing dasymetric methods

- Estimates are constantly improving with emerging data

Thank you!

California Demographic Research Unit
https://dof.ca.gov/Forecasting/Demographics/

DRU Data Hub
https://dru-data-portal-cacensus.hub.arcgis.com/

General Inquiry
ficalpop@dof.ca.gov

California Office of Data and Innovation

https://innovation.ca.gov
@californiaODI

Fennis Reed
CA Department of Finance

(916) 323-4086 x2542
fennis.reed@dof.ca.gov

https://cagov.github.io/data-infrastructure/data/footprints/

Thank you

Next GIS CoP Monthly Forum

Wednesday, March 27th , 2024

Questions or comments send to: gio@state.ca.gov